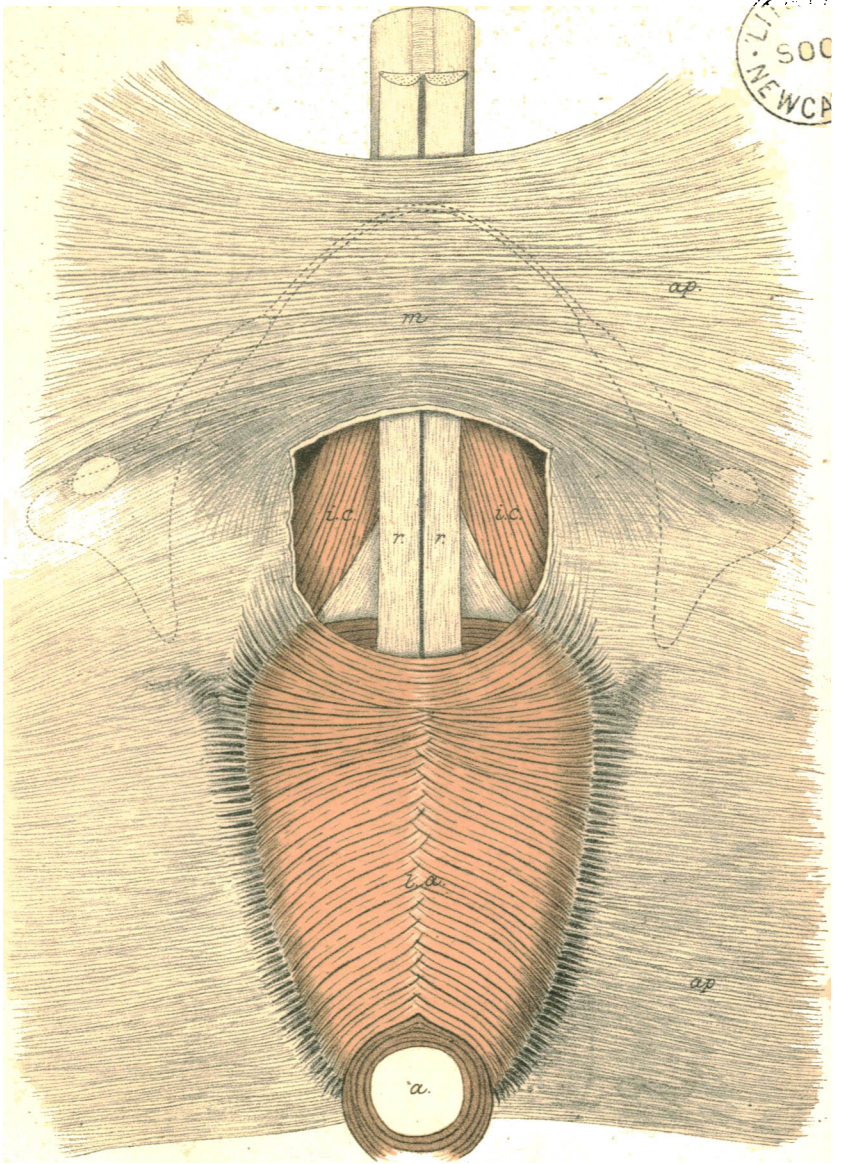

Fig. 1.

John Struthers del. F. Huth, Lith^r Edin^r

RUDIMENTARY HIND-LIMB OF BALÆNOPTERA MUSCULUS.

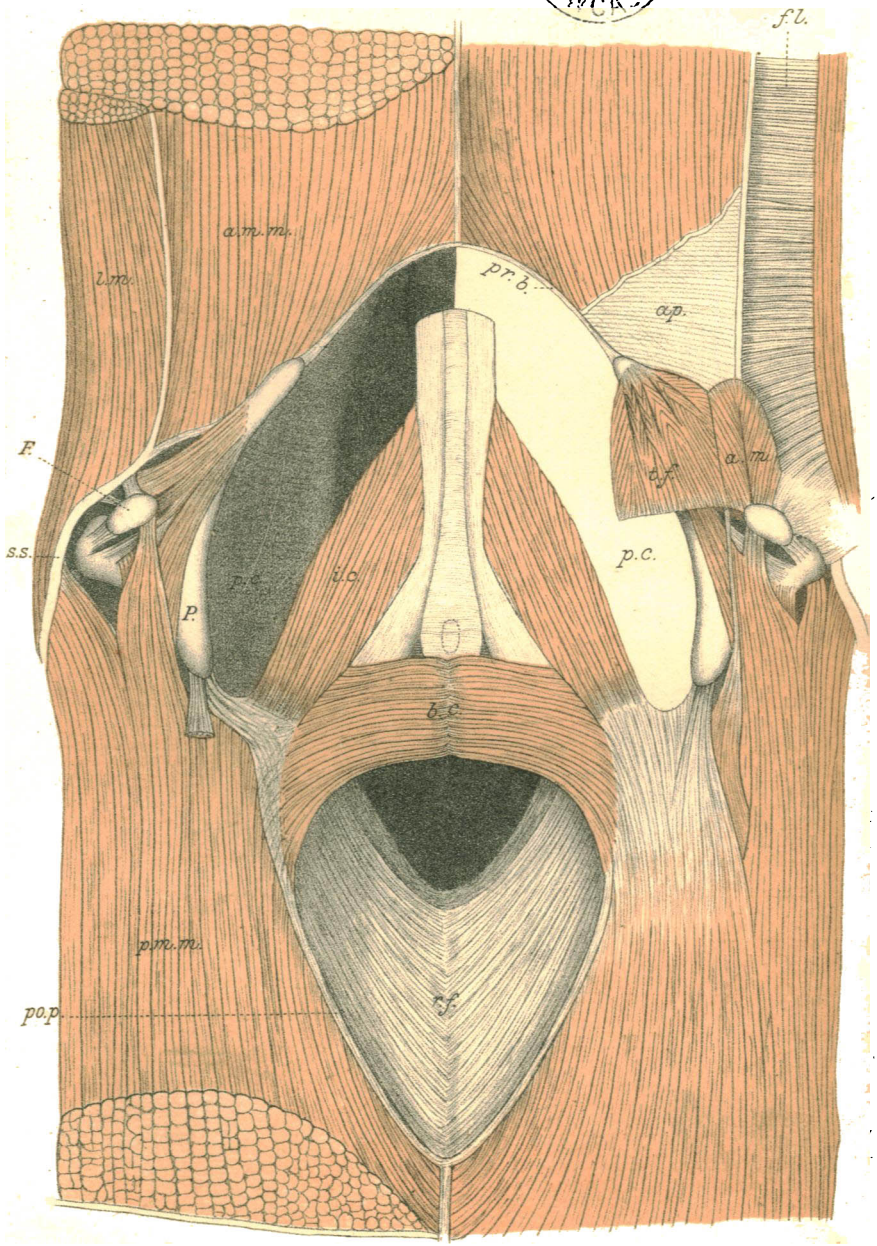

Fig. 2.

John Struthers del.

F. Huth, Lith.r Edin.r

RUDIMENTARY HIND-LIMB OF BALÆNOPTERA MUSCULUS.

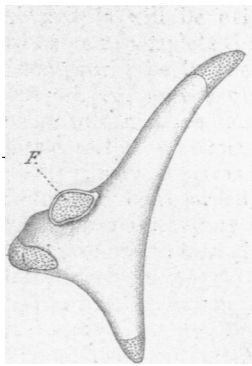

Fig. 4.

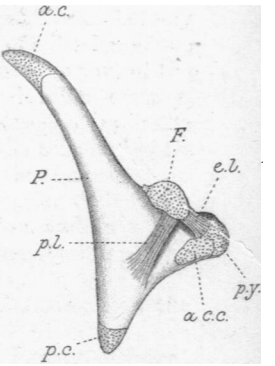

Fig. 5.

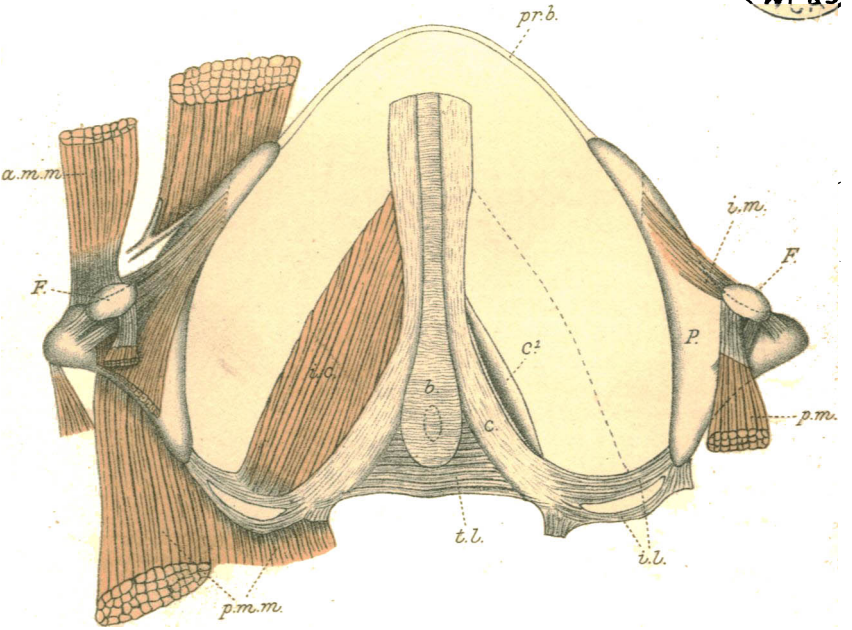

Fig. 3.

John Struthers del. F. Huth, Lith^r Edin^r

RUDIMENTARY HIND-LIMB OF BALÆNOPTERA MUSCULUS.

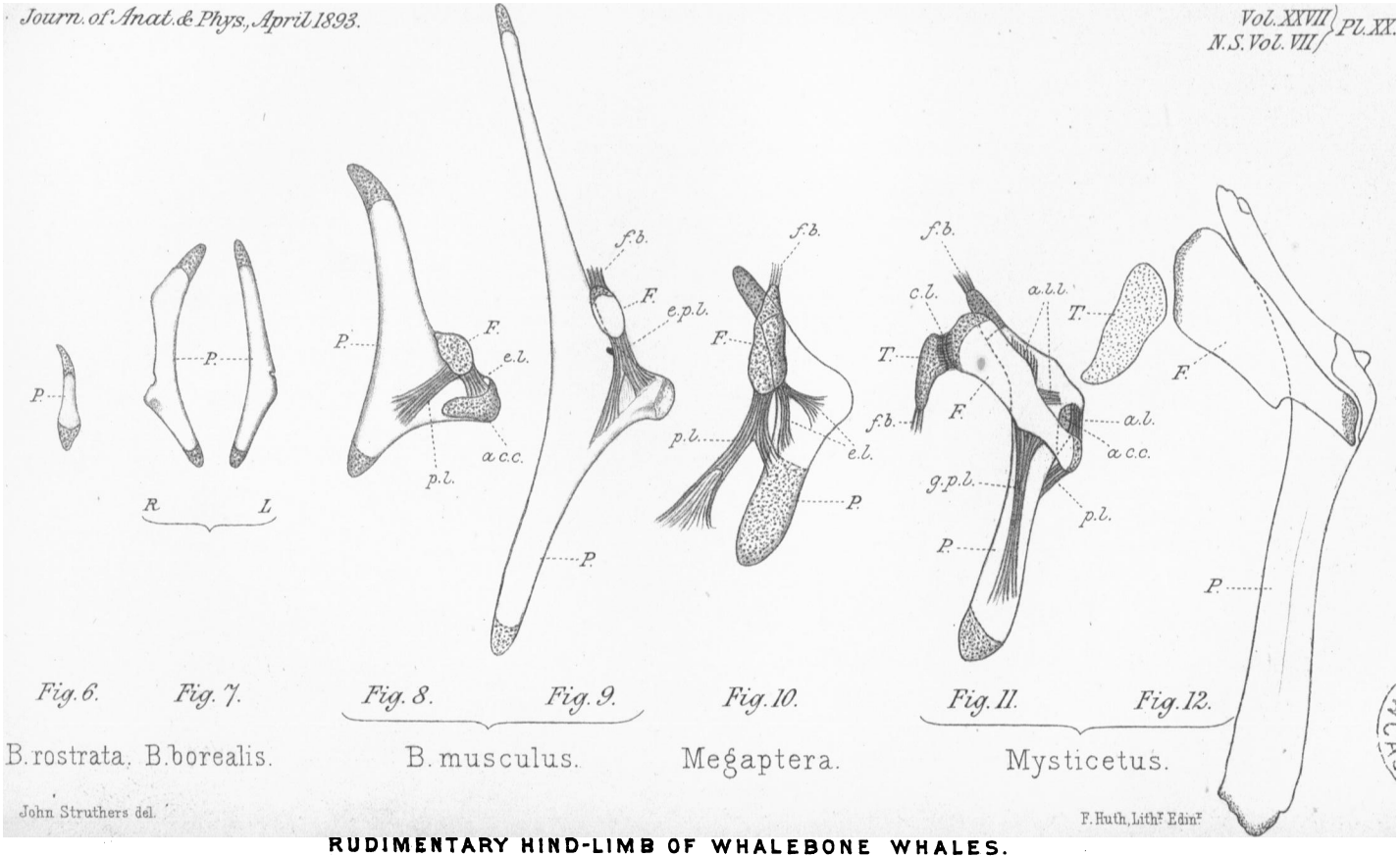

Fig. 6. B. rostrata.

Fig. 7. B. borealis.

Fig. 8. Fig. 9. B. musculus.

Fig. 10. Megaptera.

Fig. 11. Fig. 12. Mysticetus.

John Struthers del.

F. Huth, Lith^r Edin^r

RUDIMENTARY HIND-LIMB OF WHALEBONE WHALES.

Journal of Anatomy and Physiology.

ON THE RUDIMENTARY HIND-LIMB OF A GREAT FIN-WHALE (*Balœnoptera musculus*) IN COMPARISON WITH THOSE OF THE HUMPBACK WHALE AND THE GREENLAND RIGHT-WHALE.

By JOHN STRUTHERS, M.D., LL.D. (PLATES XVII.–XX.)

I EMBRACED this favourable opportunity[1] of endeavouring to ascertain what interpretation can be given to the occurrence of a part apparently so rudimentary as a thigh-bone of about the size of a pigeon's egg in a great whale; whether any definite function can be assigned to it, or whether it must be interpreted as a vestige only. This inquiry could be conducted to a satisfactory conclusion only by a searching dissection of the parts in the neighbourhood as well as of the more immediate connections. A large mass, of the whole thickness of the abdominal wall, including all the pelvic parts, was cut out of the carcase and preserved so as to keep the tissues fit for dissection. Full-sized drawings were made as the dissection went on, and these are now reduced to $\frac{1}{6}$ in the figures, Plates XVII., XVIII., XIX., and XX. It will greatly facilitate the reading if these draw-

[1] *History of this Whale.* It was found stranded on the beach at Nairn on Dec. 18, 1884. By communications from my former pupil Dr Brodie Cruickshank, of Nairn, and my friend Mr Alex. Macfarlane of the Custom House there, I inferred that it was a Razorback (B. musculus). It was sold to Mr Davidson, oil-merchant, Aberdeen, for £6; the nett proceeds, after deducting expenses and salvage, accruing to the Crown being £1, 15s. 5d. It was towed round to Aberdeen on February 2. The landing was a difficult operation. The endeavour to drag it up the bank of the river on rollers, 20 horses yoked to the ropes, having failed, it was towed round to the sheer-poles at the dock, hoisted in mid-air with tackle fastened round the tail, placed on a series of large waggons, and dragged on them by two dozen of horses and a large number of men to the recreation grounds for exhibition. The carcase was sufficiently fresh to enable me to give a satisfactory demonstration of the characters of this species to my students. I purchased and macerated the bones for the University, and the skeleton was mounted in portions, but not yet as a whole, when I left Aberdeen. It was the bones of this *B. musculus* that I gave the measurements of, in comparison with those of the 40-feet-long *Megaptera longimana*, in my account of the latter, in *This Journal*, 1887–8–9.

ings, with the accompanying explanation, are first looked at. I am now able to give at the same time a comparison of the parts with the corresponding parts in the Humpback Fin-whale (*Megaptera longimana*) and in the Greenland Right-whale (*Balœna mysticetus*). As my accounts of the dissection of these whales have at different times all appeared in this *Journal*, and as the comparison implies frequent reference to them and to the accompanying drawings, the references may be given simply as (Megaptera, 1887–8–9) and (Mysticetus, 1881). The parts of the text relating to comparison with these other whales are placed within [ ] brackets. Reference will also be made to my account of the pelvic bone and femur, with figures, of a 64-feet long B. musculus in this *Journal* (vol. vi., 1871). The B. musculus now to be noticed, also a male, was 50 feet in length. A preliminary notice of this dissection was given at the meeting of the British Association in Aberdeen in September 1885, by which time all the dissections now to be described had been made.

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I. Pelvic Bone and Femur.

Measurements of the Pelvic Bone and Femur.

The following Table gives these measurements, in inches, in this 50-feet-long B. musculus, and, for comparison, in the 64-feet-long B. musculus. The breadths (transverse) and thicknesses (vertical) show the change of form of the anterior and posterior parts of the pelvic bone at different parts.[1]

A.—The 50-feet-long B. musculus. B.—The 64-feet-long B. musculus.	Length.		Breadth.		Thickness.	
	A.	B.	A.	B.	A.	B.
Pelvic bone, straight, including cartilages,	$10\frac{1}{8}$	23				
,, anterior portion, or beak,	9	$13\frac{1}{2}$				
,, posterior portion,	$5\frac{1}{2}$	$10\frac{1}{2}$				
,, ossified part,	$8\frac{1}{8}$	$20\frac{1}{4}$				
,, anterior cartilage,	$1\frac{1}{4}$					
,, posterior cartilage,	$\frac{3}{4}$					
,, at 1 inch from end of anterior portion,	...	...	$1\frac{1}{8}$	$\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{3}{4}$
,, at middle of anterior portion,	...	...	$1\frac{3}{8}$	$\frac{7}{8}$	$\frac{7}{8}$	1
,, at 3 inches in front of promontory,	...	...	$1\frac{1}{2}$	$1\frac{1}{2}$	$\frac{5}{8}$	$\frac{5}{8}$
,, at the promontory,	...	...	$4\frac{3}{8}$	4	$\frac{3}{4}$	$\frac{5}{8}$
,, at 2 inches behind promontory,	...	...	2	2	$\frac{3}{8}$	$\frac{3}{8}$
,, at 1 inch from end of posterior portion,	...	...	1	1	$\frac{3}{8}$	$1\frac{1}{4}$
Femur,	$1\frac{3}{8}$	2	$1\frac{1}{16}$	$1\frac{1}{4}$	$\frac{7}{8}$	$\frac{5}{8}$

[1] The measurements of the femur and pelvic bone in the 50-feet-long B. musculus include the periosteum, which is $\frac{1}{16}$ inch thick on the femur, and $\frac{1}{16}$ to $\frac{1}{8}$ inch on the pelvic bone. About $\frac{1}{8}$ inch has, therefore, to be deducted from the breadth and thickness of the femur of it, as given in the Table, for exact comparison with the femur of the 64-feet-long one. The pelvic bone and femur of the latter are cleaned and dried. The measurements of the anterior and posterior portions of the pelvic bone are taken from the middle of the outer border of the promontory to the tip of each. The length of the cartilages is taken from the end of the ossified part, ascertained by passing in needles, not from where the cartilage overlaps the rounded end of the bone, which may be as much as $\frac{1}{4}$ inch on the surfaces, and $\frac{3}{4}$ inch on the borders. There is slight a-symmetry on some of the measurements. The right *pelvic bone* is $\frac{1}{4}$ inch longer than the left, seen on its ossified part as well as on the total length. The left is $\frac{1}{4}$ inch broader than the right at the promontory. In the Table the mean is given for these measurements. The $\frac{7}{8}$ inch thickness of the *femur* given in the Table is that of the right, that of the left is $\frac{1}{16}$ inch less. I obtained the bones only of the left side of the 64-feet-long B. musculus.

(A) *The Pelvic Bone.*

The differences presented by the pelvic bone in these two specimens of B. musculus (figs. 8 and 9) are so striking that, on first sight, they might be taken as belonging to different species. But the differences are owing merely to prolonged ossification at the anterior and posterior ends. At the promontory, and for three inches before and two inches behind it, the central region of the bone, the dimensions correspond closely. Notwithstanding the seeming greater breadth at the promontory in the younger specimen, the breadth exceeds that in the older specimen by only $\frac{1}{8}$ inch, allowing $\frac{2}{8}$ inch for the periosteum still on the former. The enormous elongation in the older specimen, giving a length more than twice that in the other ($10\frac{1}{8}$, 23) is more than one would expect in the growth of an individual from 50 to 64 feet, being an increase of between a fourth and a third on the length.

In the older specimen, the *anterior portion* or beak of the bone shows great difference in form on its anterior half, becoming much flattened laterally, in contrast with the vertical flattening of the central region of the bone. The measurements of the anterior portion of the bone show that, at its middle, the thickness has already begun to exceed the breadth, and that, near the end, the thickness is thrice as great as the breadth, so that the terms *thickness* and *breadth* might here be reversed. What is the inner border opposite the promontory runs forward as the superior and inferior borders of the anterior portion, and the outer border at the promontory becomes nearly lost on the anterior third of the anterior portion of the bone. In the younger specimen, the breadth at the middle is still much greater than the thickness, and, near the end, the thickness is only about a third greater than the breadth. The outer border does not fall away so soon as in the older specimen, so that in the younger one the beak maintains, throughout its yet ossified part, a prismatic form, more marked on the left bone than on the right. But the increase of the flat internal surface forwards is well marked. Thus, the part corresponding to the laterally much-flattened anterior half of the beak in the full-grown specimen is not yet developed in the younger one.

On the *posterior portion* of the bone, in the older specimen,

the thickness near the end has come to exceed the breadth by $\frac{1}{4}$ inch, but in the younger specimen the thickness at that part is less than the breadth by $\frac{1}{4}$ inch. In the latter specimen, the thickness increases a little (to $\frac{7}{8}$ inch) close to the end, on the cartilage, with a flattened surface on the inner aspect. In the more mature specimen, this flattened surface begins about six inches from the posterior end, bounded by the bifurcation backwards of the inner border of the central region of the bone, and the outer border of the central region becomes much rounded off on the posterior third of the posterior portion of the bone. Thus its thick posterior half, which gives this portion of the bone its robust character in the full-grown specimen, is not yet developed in the younger one. The flattened inner surface attaches the great interpelvic ligament on which the crus penis is set. Both of these specimens are male.

Acetabular Cartilage—(Figs. 4, 5 and 8, *a c, c*).—It is very interesting to find this cartilage present in B. musculus, representing the socket of a hip joint, although the vestigial femur does not rest on it. In *mysticetus*, in which I first met with it, the neck or head of the more developed femur rests on it, with a synovial cavity between, forming a true hip joint. Concealed by the periosteum here, as in *mysticetus*, it might readily be overlooked, or it might carelessly be taken for a growing cartilage of the promontory. A little observation, however, shows that it is not the latter, but that it corresponds very closely to the acetabular cartilage constant in my specimens of *mysticetus* (this *Journal*, 1881, p. 168, 17 and 18, and seen in fig. 11, *a c, c*, of this paper). On comparing it with one of these, still preserved moist, the correspondence is manifest. In this B. musculus the main part of the cartilage lies behind the promontory, on the under aspect of the bone, forming an ovoid elevation, like a broad almond, 1 to $1\frac{1}{4}$ inch in length, $\frac{5}{8}$ inch in breadth, about $\frac{1}{6}$ inch in thickness at the middle, less towards the edges, which are well marked. The outer edge is $\frac{1}{8}$ inch from the border of the bone, the bone here beginning to be excavated for the cartilage. On raising the cartilage from the bone, to which it adhered very intimately, the bone is seen to present a well-marked though shallow fossa corresponding to the above-mentioned dimensions of the main part of the carti-

lage. The periosteum over the cartilage is very thin, and so adherent that it was dissected off with difficulty, contrasting in both of these respects with the periosteum near it and on the rest of the pelvic bone.

From this oval and convex main part, the cartilage sends a thin prolongation forwards and outwards on the superficial surface of the promontory, as far as the border, and then ceases, except at the hinder slope of the promontory, where, as in *mysticetus*, a thin tongue, about $\frac{1}{2}$ inch in length, goes round the border for about $\frac{1}{8}$ inch on the upper aspect of the bone. The cartilage is thin where it reaches forwards on the promontory and very thin towards the border. From the position of the main part, and as the cartilage does not cap the promontory like a growing cartilage, this cartilage cannot be regarded as a growing cartilage of that projection. The inner edge of its prolongation on the promontory retains some thickness, and here it gives attachment to the external ligament of the femur. Were the inner edge of the cartilage, and of its forward prolongation, to become ossified, a bony ridge would be formed like the anterior part of the ridge seen on the bone in the 64-feet-long B. musculus to which the now dried ligament of the femur is attached (1871, fig. 3), and, external to that ridge, rough depressions are seen on the now cleaned bone, suggesting that this cartilage had been present. In this less mature B. musculus the locality of the cartilage is marked on the bone by the oval fossa for the main part, and by a flat area for the anterior part, the latter bounded internally by a sharp edge corresponding to where the external ligament of the femur is attached. The area occupied by the cartilage in my specimens of *mysticetus* is seen on the macerated bones.

[The presence of the acetabular cartilage in B. musculus is the more remarkable, as I could find no vestige of it in my 40-feet-long *megaptera* (this *Journal*, vol. xxii., 1888, p. 273 and p. 279), in which the femur is larger and longer than in B. musculus, and in which the ossification of the pelvic bone is not so advanced as it is in this B. musculus. In the *megaptera*, rather internal to the corresponding part of the pelvic bone, there is an elongated elevation of the bone to which the external ligament of the femur was attached, and against which the cartilaginous femur may have loosely rested, but there is no cartilage whatever there or on the promontory.]

(B) *The Femur*—(Fig. 8, F, and other figures).

The femur is of a generally oval form: the diameters, stated generally, are, without the peri-chondrium, length 1½ inch, breadth 1 inch, thickness ¾ inch. The surfaces are superior (deep) and inferior (superficial); the borders, anterior and posterior; the ends, external (towards the promontory) and internal. The oval outline is not quite uniform, the broad posterior border showing two elevations, separated by a groove running obliquely outwards and upwards between them. The internal elevation attaches the tendon of the posterior muscle; the external elevation, placed well towards the deep surface, attaches the posterior ligament of the femur. Where this great ligament is attached in *mysticetus*, this prominence is generally very marked on the bone. The outer end attaches the external ligament of the femur; a fibrous tuft remains attached to the inner end, and to this tuft were attached some of the muscular fibres to be noted below (p. 318).

On section, the femur is seen to be entirely cartilaginous, closely enveloped by a $\frac{1}{16}$ inch-thick peri-chondrium. The vascular channels, seen by the naked eye to permeate abundantly the much larger entirely cartilaginous femur of *megaptera* and the tibia of *mysticetus*, are seen in the femur of this B. musculus with the aid of a lens. In the 64-feet-long B. musculus, the femur, 2 inches in length, is ossified in its outer or posterior three-fourths, but that ossification is not necessarily a matter of age is seen from the fact that in the 67-feet-long B. musculus, also a male, in which the presence of a femur was discovered by Sir W. H. Flower (*Pro. Zoo. Soc.*, 1865), the femur was in the condition of a cartilage, 1¼ inch in length by ¾ inch in breadth. Variation is to be expected in parts so rudimentary.

Ligaments of the Femur.—The ligaments connecting the femur to the pelvic bone are an external, a posterior, and an interosseous. (1) *External ligament* (figs. 4, 5 and 8, *e*, *l*). Length, on superficial surface, ¾ to 1 inch; breadth ½ inch; thickness ¼ inch. Attachments, externally, at about ¾ inch from outer edge of promontory, being at the ridge bounding internally the forward prolongation of the acetabular cartilage; internally, to the outer end of the femur, running further on the posterior than on the anterior border. Direction, inwards and a

little forwards. It will check movement in that direction, and it is a strong ligament for so small a femur. (2) *Posterior ligament* (figs. 4, 5, and 8, *p*, *l*). Length, on superficial surface, $2\frac{1}{4}$ to $2\frac{1}{2}$ inches; breadth, at the narrowest part, $\frac{1}{2}$ inch, expanding a little towards the femur and backwards on the pelvic bone. Thickness about half that of the external ligament. Its attachment at the femur is to the external elevation, above noticed, on the posterior border towards the deep surface. There is no cartilage or special roughness on the pelvic bone where this ligament is attached to it, nor is the ridge that bounds internally the fossa for the acetabular cartilage continued to where this ligament is attached, or continued backwards beyond the fossa. The direction of the ligament is forwards and considerably outwards. It is a strong ligament, and will resist forward movement of the outer part of the femur. (3) *Interosseous ligament.* This short ligament is concealed by the outer part of the femur and by the anterior part of the posterior ligament, and is therefore not shown in the figures. Length under $\frac{1}{2}$ inch, breadth $\frac{1}{2}$ inch. Its direction towards the femur is a little forwards, and it will mostly check forward movement. It would also check much backward movement of the outer end of the femur, and much lifting of the femur off the pelvic bone, but the latter does not seem to be a possible movement by any muscular structure present. These three ligaments are all attached to the outer part of the femur, and might be taken for a kind of capsule to the head of the bone, but they are distinct ligaments. They offer strong resistance to inward and forward muscular traction on the femur, but not to backward muscular traction on the inner part of the femur.

In the 64-feet-long B. musculus, the external and posterior ligaments (fig. 9, *e*, *p*, *l*) form one large triangular ligament, bifurcated posteriorly, a thinner portion filling the interval. It is attached to the outer or posterior end of the femur, and, at the pelvic bone, to a 4-inch-long ridge, corresponding to the inner boundary of the area for the acetabular cartilage in this less mature B. musculus, with a prolongation of that boundary backwards. The more transverse position of the femur in this 50-feet-long B. musculus may account for the ligament being differentiated in it into two distinct ligaments.

[In *mysticetus* the posterior ligament (fig. 11, *g*, *p*, *l*) is quite separate and very large, and is attached to a usually well-marked prominence on the femur, some way internal to the head and neck; and there are anterior and posterior ligaments of the head, and two interrosseous ligaments of the body of the femur. In *megaptera*, although the femur is placed antero-posteriorly, the external and posterior ligaments are distinct (fig. 10). The posterior was large and bifurcated backwards, and the internal limb contained a true muscle. An appearance to the naked eye of muscular streaks in the posterior ligament in the 50-feet-long B. musculus was deceptive, as shown on examination under the microscope.]

Position and Mobility of the Femur.—The femur, with its long axis directed inwards and a little forwards, has the following position. Outer end, $1\frac{1}{2}$ to $1\frac{3}{4}$ inch from the extreme outer edge of the promontory of the pelvic bone, and $\frac{3}{4}$ inch distant from the nearest part of the acetabular cartilage. From a third to a half of the breadth (more on the left than on the right side) projects in front of the anterior border of the pelvic bone. Most of its very convex deep surface thus rests on the pelvic bone; but there is no cartilage on the pelvic bone here, only the usual periosteum; nor any special excavation, but only the general shallow concavity of this region of the bone. There is no synovial membrane, only a little of the usual cetacean fat and areolar tissue, and part of a muscle mixed with fibrous tissue (p. 319). The femur slips about very loosely, except in so far as restrained by the ligaments above noticed, and as retained in position by the muscular and fibrous structures to be noticed below.

II. The Muscles and other Soft Parts.

Formation of the Cetacean Perineum and fibrous Pelvic Cavity.—Preliminary definition in comparison with the quadrupedal pelvis will simplify, and the accustomed nomenclature of human anatomy is quite applicable. Fgures 1, 2, and 3 may be referred to generally. Imagine, in the human body, only an elongated ischium to be present, the rest of the bony true pelvis represented by fibrous membrane; the pubic arch and symphysis to be represented by a fibrous band, and the perineum to be bounded behind by a fibrous band in the position of the lower edge of the great sacro-sciatic ligament. There is thus, in the cetacean, a large oval or elliptical gap in the abdominal wall

representing the pelvic cavity and perineum. The parts presented on dissection from the surface are those of the perineum, having a narrow bar of bone, the pelvic bone, along part of each side. Although there is no bony pelvis above the perineum, there is a soft-walled pelvic cavity, formed at the sides by the longitudinal muscular masses, and before and behind by the convergence and meeting of these masses; all smoothly lined by a very strong aponeurosis, the pelvic fascia, from the brim above to the outlet below. At the outlet, this fascia is attached to the upper edge of the pelvic bone and pre-pelvic band; and to the lower edge of the bone, and to the pre-pelvic band, is attached the deeper layer of the strong interpelvic membrane, thus closing the pelvis and giving support below. The wall slopes upwards and inwards, giving the cavity the form of a funnel reversed, so that while, in this B. musculus, the width of the outlet at the anterior end of the pelvic bones is 10 inches, that of the inlet above that point is only 6 inches. The pelvic cavity has a height of at least 5 inches above the pelvic bone as the parts lie on the dissecting-table, probably more when in the natural position. The upper opening, or inlet, of this soft-walled pelvis receives the bladder and rectum. The outlet, or perineum, below, a large ovoid area, is divided into anterior and posterior parts by the great interpelvic ligament, each about 14 inches in length. The anterior division, broadly heart-shaped, is bounded at the sides by the pelvic bones, and in front of them by the band connecting the anterior ends of the pelvic bones, the pre-pelvic band, uniting with its fellow in an anterior symphysis. The posterior division is bounded laterally by a post-pelvic band, uniting with its fellow in a posterior symphysis. The posterior or rectal division, described as the rectal fossa, transmits the rectum, emerging from the posterior part of the pelvic cavity, into which it is bound below by the great funnel-shaped levator ani muscle. The anterior, or genito-urinary, division contains in the centre the parts of the penis and urethra with their muscles, and on each side of these is a wide space (2 to 3 inches wide) which is packed with a mass of loose areolar tissue and fat, allowing of distention of the central parts, or of compression of them by the coming inwards of the movable lateral boundary. The pelvic bone lies at and bounds the two posterior

thirds of the genito-urinary division. The distance between the right and left pelvic bone is, at their posterior end 16 inches, at their anterior end 10 inches.

The muscles and other soft parts in relation with the pelvic bone and femur may be considered under three heads. (a) The relation of the pelvic bone to the genital organs. (b) The muscles attached to the pelvic bone. (c) The muscles attached to the femur. Previous reference to the figures and their explanation will greatly facilitate the reader in following the account of the muscles and their connections.

(A) *Relation of the Pelvic Bone to the Genital Organs.*

Great Interpelvic Ligament.—This great ligament is seen in figure 3 (*i*, *l*), passing across between the posterior ends of the pelvic bones, supporting the crura penis and attaching muscles. Its attachment to the bone is at the end and to $\frac{3}{4}$ inch of the inner surface (the as yet cartilaginous part), here flattened, and from this it is continued forwards along the inner side of the bone as a thick fascia. The length of the ligament between the bone and the crus penis is $3\frac{1}{2}$ inches. This part of the ligament is divided in most of its length by an elliptical interval into an anterior and posterior part. The posterior part is about one third of the bulk of the anterior, and gives attachment along its whole length to the inner part of the posterior muscular mass. The interval between the two parts appeared as if it had transmitted blood-vessels. The anterior part is the interpelvic ligament proper. It is flattened, like a leather strap, $\frac{3}{4}$ inch by $\frac{1}{8}$ inch, set edgeways on the pelvic bone. Along its inner half it gives attachment to the ischio-cavernosus muscle. The two portions, united at the crus penis, are $1\frac{1}{4}$ inch in breadth. The anterior and greater part of this fibrous mass joins the fibrous tissue of the crus, spreading longitudinally over chiefly the inferior surface of the crus, and contributing to the great thickness of the fibrous wall of the crus here. The more posterior portion of the ligament partly joins the end of the crus, and partly passes behind and on the under surface of the crus to join the triangular ligament, thus joining the fibres from the opposite pelvic bone.

The *Triangular Ligament*, or intercrural ligament (fig. 3, *t*, *l*),

occupies the space between and connects the crura penis, is pierced anteriorly by the urethra, and is in part concealed on the under surface by the bulb of the corpus spongiosum. It is a strong structure, behind about $\frac{1}{3}$ inch thick, thinner towards the hinder edge. For its posterior inch it is composed of uninterrupted transverse bundles. In front of this it sends a covering of transverse bundles over the bulb, the fibrous covering of which is $\frac{1}{2}$ inch thick, that of the corpus spongiosum, in front of the bulb, being only $\frac{1}{8}$ inch thick. At the sides the triangular ligament becomes continuous with the longitudinally directed fibrous bundles of the crura, chiefly with the thick fibrous plate on their under surface. The strain against separation of the pelvic bones must be borne chiefly by this thick fibrous plate on the crus, through its connection with the interpelvic ligament externally and with the triangular ligament internally, as only a comparatively small proportion of the bundles of these two ligaments pass across behind and under the crura, none at all on the dorsal surface of the crura. On its upper surface, the triangular ligament attaches the bladder around where the urethra perforates the ligament.[1]

[1] *Note on the Bladder.*—What I saw of the bladder may be noted here. The attachment to the triangular ligament is 5 inches in length, an inch of it by a median fibrous band, by 1½ inch in breadth. The muscular coat of the bladder was thicker towards the neck, but nothing resembling a prostate gland was seen. The muscular coat, fully ½ inch thick, was composed of very red bundles, but examination with the microscope showed no striped fibres. The mucous and sub-mucous coats were pale, in contrast with the red muscular coat, about ⅛ inch thick, and very distensible and elastic. Length of bladder, 12 inches; breadth when empty and flattened, 3 to 4 inches. It could be distended at the middle to form a ring 3½ inches in diameter, not more. [In my account of Mysticetus reference is made to "the neck of the bladder, with its thick red muscular walls, seen under the microscope to be composed of *striped* fibre" (p. 305, 1881). I am unable to account for this discrepancy if there is an error. On referring to my notes of the dissection of Mysticetus I see that, when the observation under the microscope was made, I had still remaining a portion of the bladder 2½ inches in length by 3½ inches in breadth, attached round the perforation in the triangular ligament, noted as with "very thick walls, dark red muscular fibres, fully striped under the microscope. Central cavity lined by mucous membrane, admits of being much dilated. No trace of seminal ducts or of anything like a prostate." It is noted that large red muscular bundles join the bladder to the interpelvic ligament, around and near the aperture, and pass on the surfaces as longitudinal bundles and also in part as circular bundles. The muscular fibres of this part of the bladder of Mysticetus were undoubtedly of the striped kind. I do not think

[The interpelvic ligament in B. musculus is not so large a structure as in Mysticetus or in Megaptera. In the 40-feet-long *megaptera* the ligament was 1½ to 2 inches in breadth, antero-posteriorly, and about ½ inch thick, and met the crus penis at 2½ inches from the pelvic bone. This greater size of the ligament in Megaptera is in adaptation to the greater breadth of the penis and its crura, and of the ischio-cavernosus muscle (*loc. cit.*, fig. 15). The ligament is still broader and thicker in *mysticetus*, meets the crus penis much sooner, and sends strong bundles across the dorsal surface of the crus to join those from the opposite pelvic bone on that aspect of the triangular ligament. The crus penis and the muscle are much larger in Mysticetus (*loc. cit.*, figs. 11, 12, 13, and 14).[1]]

(1) *Levator ani muscle.*—This great muscle, covering the under surface and part of the sides of the rectum, seen in full view in fig. 1 (*l*, *a*), presents a funnel shape, tapering backwards. Length, fully 12 inches; breadth, 10 to 11 inches towards the fore part, 6 to 7 inches at the back part; thickness, as seen on section, 2 inches, diminishing to 1 inch behind, and thinning a little also towards the anterior border. It arises, anteriorly, for two to three inches from the general superficial aponeurosis internal to the position of the pelvic bone; externally, from the great interpelvic ligament; and chiefly, along the side, from the post-pelvic band. The direction of the great bundles presented by the muscle may be noted as contrasting, except at the fore part, with their direction in Megaptera.

it likely that the fibres I placed under the microscope in B. musculus were taken from the superficial bundles prolonged from the retractor penis muscle. As noted below (p. 309) these are pale, and very unlike the deep red bundles of the muscular coat of the bladder.]

[1] Some differences of the crus penis in B. musculus, as compared with Mysticetus, may be noted here. In this 50-feet-long B. musculus, the erectile tissue goes back close to the posterior end of the crus. There it is about the size of the little finger; forwards, at the middle of the crus, it is about the size of the transverse section of a hen's egg. The fibrous wall on the free under surface of the crus is ⅛ inch thick. In the 35-feet-long *mysticetus* (*loc. cit.*, p. 302, figs. 11 and 12) the erectile medulla ceases 2 inches from the posterior end of the crus, being on a level with where the anterior part of the interpelvic ligament joins the crus. There, beginning abruptly, it is about the size of the fore-finger, much larger in front of this. That is in the collapsed condition. The fibrous cortex of the crus is nearly 1 inch thick on the under surface. The crura are thus much larger and more firmly supported in Mysticetus than in B. musculus, and are, in addition, in Mysticetus, completely covered and supported by the posterior compressor muscle. I had noted of *megaptera* that the penis is much broader than in this B. musculus, and of the crus, that at its conical hinder end the fibrous wall was ¼ to ½ inch thick, with erectile tissue internally.

Curving inwards to the middle line, at the anterior 2 to 3 inches, the direction is backwards; then a few pass directly inwards; then, along the great part of the muscle the direction changes to forwards, increasingly so as we go back, and curving with the concavity backwards. There is no distinct median raphé, the bundles merely interlacing and decussating irregularly at the middle line below.

At the anus, for about 2 inches, the arrangement is modified so as to form a sphincter muscle, the bundles arising on each side from the post-pelvic band passing above as well as below the bowel. This part of the muscle is about 1 inch in thickness, increasing in thickness backwards. It is not certain that I had the parts quite to the anus. This strong red sphincter ani, or recti, contrasts with the pale ½ inch thick muscular coat of the bowel in front of it, composed chiefly of circular fibres, but covered by an external longitudinal stratum.

When the rectum is removed a long deep fossa is exposed, *rectal fossa*, shown in fig. 2 (*r, f*). This is the rectal portion of the pelvic cavity, directed obliquely backwards and downwards, about 13 inches in length. The sides and roof are formed by the posterior muscular mass of each side, lined by a strong fascia. The fibres of this fascia pass from the post-pelvic band to meet in the middle line of the roof, those along the posterior 8 inches with a definite direction inwards and backwards. In this fossa the rectum will be compressed by the levator ani muscle below, and at the sides and above by the contraction of the posterior muscular mass. The rectum is surrounded by loose areolar tissue and fat.

The *post-pelvic band*, above referred to, is shown on the surface in fig. 1 along the side of the levator ani muscle, and in fig. 2 (*po, p*) as the boundary of this part of the pelvic outlet. In front it is connected to the hinder end of the pelvic bone and with the great interpelvic ligament. At the latter connection it is continuous with the fibrous ridge on the crus penis, there and for several inches backwards bounding and attaching the bulbo-cavernosus muscle. Behind, it joins its fellow in a posterior symphysis, where the right and left posterior muscular masses meet mesially, thus bounding the outlet of the pelvis. Deeply, it is continuous with the fibrous wall of this part of the

pelvic cavity. Superficially, it is connected inwards with the fascia on the surface of the levator ani, outwards with the thick fascia on the surface of the posterior muscular mass. The post-pelvic band is a strong structure, and is important as a boundary and as giving origin to several muscles.

[In *megaptera*, all but a few of the anterior bundles of the levator ani muscle are directed obliquely backwards to the middle line below, where they decussate irregularly. None of it appeared to go on the upper surface of the rectum till near the anus, and there the bundles decussate obliquely and pass round. The reason for the backward direction of the bundles of the great body of the muscle appears to be, that the bulk of the muscle arises from the interpelvic ligament and end of the pelvic bone. I have no note of the presence of such a structure as the post-pelvic band, subsequently found in B. musculus, giving continued origin backwards to the levator ani; but the posterior muscular mass is noted as meeting its fellow in a median septum, just behind the anus. In the figure given of megaptera (*loc. cit.*, fig. 15), only the anterior part of the muscle is shown. In *mysticetus* (*loc. cit.*, fig. 13) also only the anterior part of the muscle is shown. The back part of the muscle had been mutilated. The anterior part is seen to arise further forwards than in the two finners, carried forwards by the horse-shoe septum.]

(2) *Bulbo-cavernosus muscle.*—This muscle is shown in full view in fig. 2 (*b*, *c*). It measures, transversely, 7 inches in front, increasing to 10 inches behind; antero-posteriorly, 3 inches at the middle, increasing to 6 inches externally; in thickness at the anterior border, $\frac{3}{4}$ inch. It is composed of large red bundles, interrupted at the middle line by a fibrous septum, dividing the muscle in its whole length and thickness, and showing itself on the surface as a raphé with tendinous bundles on each side. For comparison with its greatly developed homologue in Mysticetus, the median septum may be described as the origin of the muscle. It arises also, more deeply, from the under surface of the great interpelvic ligament. The external attachments of the muscle are, posteriorly, to the post-pelvic band above described; anteriorly, including the thicker part of the muscle, to the crus penis, on which it is separated by a firm fibrous ridge from the attachment of the ischio-cavernosus muscle to the crus. The direction of the bundles is, at the anterior part, a little backwards, towards the back part very much backwards. The deep surface is, anteriorly, entirely adherent to the crura penis and posterior part of the

bulb; posteriorly, unattached, in relation with the now expanded retractor penis muscles. The superficial surface is concealed in more than its posterior half (fig. 1), by the levator ani muscle, and, at the middle, by the rope-like retractor penis muscles, now becoming flattened before they turn round the posterior border of the bulbo-cavernosus. Where this muscle and the levator ani are attached to the post-pelvic band the bundles might seem to be continuous, as if forming a circular muscle, but they are not really continuous. Fig. 1 shows the elliptical space between these two muscles through which the two rope-like retractors pass. The actions of the bulbo-cavernosus muscle must be to draw the crura penis and, through the interpelvic ligament, the pelvic bones towards each other; also to compress the back part of the bulb and of the crura, and to give general support to the penis.

(3) *Ischio-cavernosus muscle.*—This large muscle is shown, on the under aspect, in full on both sides in fig. 2 (*i c*), on the right side in fig. 3, and in part on both sides in fig. 1. Length, at the outer side, 11 inches; greatest breadth, on the surface, 3 inches; breadth on section, 2 to $2\frac{1}{2}$ inches. Though the name is homologically correct, the muscle has no direct counection with the pelvic bone in B. musculus. The more external part arises from more than the inner half of the great interpelvic ligament by a series of thin tendinous laminæ, the more internal and deeper bundles from the outer part of the crus penis on both aspects. The bundles pass forwards and inwards to be inserted into the corpus cavernosum, and in part into the crus. The cortex of the part of the crus covered by and attaching the muscle is soft and compressible, and only $\frac{1}{6}$ inch thick, in contrast with the part of the crus not covered by the muscle. This latter part of the cortex, between the inner edge of the muscle and the bulb, forms a hard fibrous plate $\frac{5}{8}$ inch in thickness, marked off from the soft part by a strong ridge. This ridge, overhanging and giving origin to the ischio-cavernosus, rises for $\frac{3}{4}$ inch, is at the base $\frac{1}{2}$ inch thick, and tapers to a blunt margin. This fibrous ridge (shown on the left crus in fig. 3) will be seen to correspond to the horse-shoe septum in Mysticetus. The ischio-cavernosus muscle, thus, in B. musculus, is far from extending inwards to meet its fellow of the opposite side on

either aspect. The interval on the under aspect is seen in fig. 2, bounded by the inwardly convex border of the muscle. On the dorsal aspect, there is, along the posterior 7 inches, a wide triangular interval, bounded by the inwardly concave border of the muscle, and along the anterior 4 inches a narrow interval, $1\frac{1}{4}$ inch broad, bounded by a straight border of the muscle. At the back part of the triangular interval are seen, besides part of the crura, the neck of the bladder, and the triangular ligament between the crura. In regard to the action of this muscle, the deeper bundles, attached on the surface of the soft part of the crus and at their other end to the inter-pelvic ligament behind or to the corpus cavernosum in front, should at first have the effect of dilating the wall of the erectile medulla; but the swelling of the contracted muscle should rather have a compressing influence when the crus is distended. The general action of the muscle along with its fellow, and with the bulbo-cavernosus muscle, forming together a muscular triangle, should be to grasp and support the crura and corpora cavernosa during erection.

[*Comparison of the Bulbo-cavernosus and Ischio-cavernosus muscles in B. musculus, Megaptera, and Mysticetus.*—The interpretation of the vast muscles here in mysticetus, and of the fibrous structure I described as the "horse-shoe septum," is made clear by this subsequent dissection of B. musculus. The "great compressor muscle" in mysticetus, enveloping in one great muscular covering all the parts of the penis here (1881, figs. 13, 14, 15), with median raphé on both aspects, I had interpreted as comprehending a great ischio-cavernosus muscle, and also, in the part arising from the inferior median raphé, a bulbo-cavernosus muscle, while the homology of the "posterior compressor muscle," separated from the great compressor by the horse-shoe septum, was not evident. It is now evident that the posterior compressor of mysticetus (1881, fig. 13, *m*) is the bulbo-cavernosus muscle, much more developed forwards than in B. musculus, so as to cover the whole of the bulb and greater part of the crura. The posterior bundles have a nearly transverse direction, the succeeding bundles a direction more and more forwards, to be inserted into the crus and the horse-shoe septum. The great anterior compressor of mysticetus is the ischio-cavernosus, arising not only extensively from the pelvic bone, but inwards from the horse-shoe septum, and from the median raphé on the under aspect, the whole passing to be inserted into the dorsal median raphé and corpus cavernosum.

It becomes evident, too, that the horse-shoe septum, attaining a depth of 2 to $2\frac{1}{2}$ inches, is but a greater development of the fibrous ridge on the side of the crura in B. musculus, the ridge being, in

mysticetus, carried across the bulb, or corpus spongiosum, to join its fellow of the opposite side, owing to the inward extension of the ischio-cavernosus muscle to the middle line. The fibrous ridge, or septum, on the crus in B. musculus may, moreover, be regarded as a continuation of the post-pelvic band, where they meet at the posterior end of the crus. These septa together form the lateral and anterior limits of the bulbo-cavernosus muscle in B. musculus, as the horse-shoe septum does in mysticetus. The horse-shoe septum begins within the posterior end of the pelvic bone, and along its posterior half attaches the anterior part of the levator ani muscle (1881, fig. 13, *i*), just as the anterior part of the post-pelvic band does in B. musculus. I had not the opportunity of dissecting the parts further back in mysticetus.

The correspondence of these two muscles (ischio-cavernosus and bulbo-cavernosus) in mysticetus and in B. musculus, however unlike they are at first sight, is therefore clear. The mass of these muscles, great as it is in B. musculus compared with the size of the crura and corpora cavernosa, is actually several times greater in the but half-grown mysticetus described and figured. The action of these two muscles in mysticetus, in compressing all the parts of the penis here, and in giving support to the root of the penis during erection, is evident.

In *megaptera* the ischio-cavernosus muscle, though with the same general arrangement, is much larger than in B. musculus, especially in breadth (1888, fig, 15, *f*), in accordance with the greater extent of the interpelvic ligament and greater breadth of the penis. The breadth was about twice that in B. musculus. The broad interval between the right and left muscle, on the under aspect, is seen in the figure. On the dorsal aspect, they approach within ½ inch of each other along the posterior 3 inches, then diverge forwards for the remaining 7 inches, leaving a white triangular interval, the base formed by the whole breadth of this aspect of the penis. This may be compared with the figure (14, *l*, 1881) given of the dorsal aspect of the muscle in mysticetus, in which the greater part of the muscle is seen to meet its fellow in a median raphé and septum, the anterior part separated from its fellow by a narrow interval. I estimated the total bulk of this muscle in megaptera as equal to twice that of an average human gluteus maximus muscle, but that falls far short of the bulk of the muscle in mysticetus. The great size of these muscles in the cetacea—in each of these whales the ischio-cavernosus muscle thicker than the penis—may be in adaptation to the crura penis being set upon the interpelvic ligament, instead of on the bone, and to the pelvic bone itself not being a fixed part of the skeleton.

I referred to the *bulbo-cavernosus* muscle in megaptera very shortly as the "transversus perinei" (1888, p. 275). The part of it shown in the figure (15, *d d*, 1888) is the posterior border, but the muscle, with the same general appearance as in B. musculus, faced somewhat diffierently. In my notes it is described as having one surface applied against the bulb and crura, the other towards the rectum. I

infer from my notes that the muscle was turned in part in behind the interpelvic ligament, so that the small part shown in the figure just referred to was the inferior as well as the posterior border. The muscle in megaptera was, as far as I can judge, about the same size as in B. musculus, not larger. It is noted that the bundles passed across without any median raphé, but the raphé may have been overlooked, from the condition of the parts here, which were not so fresh as in my subsequent dissection of B. musculus.

The separate bundle, about the bulk of the little finger, noted in the dissection of mysticetus (1881, p. 307) as passing across just behind the bulbo-cavernosus, between the ends of the crura penis, without median interruption, was not seen in megaptera or in B. musculus. But the crura in mysticetus form free conical projections behind the interpelvic ligament (figs. 11 and 12, 1881), which may account for the development of this separate bundle.]

(4) *Retractor penis muscle.*—This muscle, shown in this B. musculus in fig. 1 (*r r*), in Megaptera (1888, fig. 15 *e e*), and in Mysticetus (1881, fig. 13 *k k*), has the same arrangement in all these whales. Passing back, as a soft rope-like structure, close to its fellow, on the under surface of the penis and its muscles, it sinks in between the levator ani and the bulbo-cavernosus muscles, and breaks up into its bundles of origin. In this B. musculus some of the bundles passed backwards on the rectum; most of them turned upwards, some to be attached to the posterior edge of the interpelvic ligament, and some were continued forwards on the bladder, for 3 or 4 inches on its upper surface, as a pale continuous layer, contrasting with the red filres of the muscular coat of the bladder. It is composed of pale unstriped muscular fibre mixed with areolar tissue, enclosed in a fibrous sheath. It was dissected forwards in Megaptera, and seen to begin behind the middle of the penis to be inserted gradually along its outer edge, the inner part passing much further forwards.

(B) *Muscles attached to the Pelvic Bone.*

The Superficial Interpelvic and Interfemoral Membrane (Perineal Fascia).—This is a thickened part of the general aponeurosis of the region. It is figured with Megaptera (1888, fig. 15, *k k*), but a more extended view was obtained in this B. musculus, fig. 1, in which it was 3 feet in length from the anus forwards. The general aponeurosis is seen posteriorly to be attached, at the side of the levator ani muscle, to the post-pelvic

band. In front of this it passes across between the pelvic bones, covering them and extending outwards beyond them over the anterior muscular mass. The position of the pelvic bones and femur is shown by the dotted lines in the figure. Here, between the anterior portion of the bones and for some way in front of them, the aponeurosis is greatly thickened and forms the inter-pelvic membrane proper. The thickness is, over the posterior muscular mass, about $\frac{1}{12}$ inch; external to the pelvic bone, about $\frac{1}{8}$ inch; at the special interpelvic part, $\frac{1}{3}$ to $\frac{1}{2}$ inch. This thickened part is 8 inches in length, antero-posteriorly, at the middle, but the concave anterior and posterior margins, as seen in the figure, are not natural edges but the stages at which the special thickening begins. The window shown in the figure between the membrane and the levator ani is closed by a thinner portion of the membrane. The coarse bundles of white fibrous tissue composing the membrane are transverse, those in front curving a little forwards, those behind curving very much backwards opposite the femur and behind it towards the back part of the pelvic bone. The thickening of the part connecting the femur inwards suggests a strap, and here, for some inches internal to the femur, is inserted a considerable muscle (tensor fasciæ) which will be noticed with the muscles attached to the femur.

The thick part between the pelvic bones shows three strata, separated by some oily fat, which outwardly have the following connections. The superficial stratum passes to the general surface and embraces the femur, not forming a distinct capsule for it, but joining its perichondrium at both borders and at both ends. This connection is a further means of keeping the femur in its place. The middle stratum is in part attached to the pelvic bone, continuously along the posterior half, more broken up along the anterior half; and in part passes across below the bone to join the fibrous septum external to the bone, seen in fig. 2. This crossing is especially by two strap-like bands, the posterior of which lies between the fore part of the femur and the pelvic bone. The deepest stratum is attached to the pelvic bone at the inner side, and in front of this to the neighbouring part of the pre-pelvic band, and may be said thus to join the fascia lining the pelvic cavity. At the anterior part of the pre-pelvic band the continuity with the pelvic

fascia is with the layer of the general aponeurosis immediately investing the anterior muscular mass. The penis here lies in a space roofed by the latter and bounded below by the interpelvic membrane. The uses that may be assigned to this strong interpelvic membrane are, assisting to resist over-separation of the pelvic bones; closing the outlet of the anterior division of the pelvis, thereby supporting the penis and the viscera above; and assisting to retain the femur in its place.

[In *megaptera* the arrangement of the interpelvic membrane corresponded very closely to that above described in B. musculus (1888, p. 277, and fig. 15). The larger femur renders that connection more important. In the dissection of the megaptera, the following, not included in my account of it, was noted, and may be of interest here. There was a *subcutaneous muscle* supporting the penis, extending from 3 inches behind the position of the rudimentary mammæ (which are situated 2 feet in front of the anus), forwards to the preputial opening (1½ feet in front of the mammæ), and thus supporting the anterior half of the penis. Its thickness at the edge of the prepuce was ½ inch, increasing backwards to 3 inches. It ended in tendinous tissue 3 inches behind the mammary pouch. Its bundles arose from a median raphé, were directed outwards and forwards, the obliquity increasing at the anterior part, and ended in the fibrous tissue of the wall. This subcutaneous muscle was not continuous with the transverse muscular layer dissected in front of the prepuce. I had the latter for 3½ feet, to in front of the umbilical fissure. Its bundles arose from a median raphé, and were directed transversely outwards, except behind, where they curve backwards and are overlapped a little by the former muscle. This *anterior subcutaneous muscle* is fully 1 inch in thickness, increasing at the back part to 2 inches. It lay close below the blubber, and there was a layer of fat 1 inch thick on its deep aspect. Both of these superficial muscles looked as if belonging to the panniculus, separated by the preputial opening, the posterior one adapted to supporting and compressing the penis and the prepuce. Behind it, that supporting function is served by the interpelvic membrane, the thickening of which between the pelvic bones further gives it the ligamentous function of tying the bones together. The interpelvic membrane and the compressor muscle may, perhaps, be regarded as the same stratum histologically changed. In *mysticetus* the tubularly developed ischio-cavernosus muscle serves this supporting function to the penis opposite the pelvic bones, and for a considerable distance anterior to them. If any special interpelvic membrane exists in *mysticetus* it had been removed; but with a femur so much longer and so differently placed, any such membrane could not have the same arrangement as in the finners.]

The Longitudinal Muscular Masses, anterior and posterior —(Fig. 2, *a*, *m*, *m*, and *p*, *m*, *m*).—These enormous masses of

muscle manifestly could not find attachment to parts so slender as the pelvic bones. Although the appearance at first is that they pass largely along the pelvic region, it is not so; they are entirely interrupted by attachment mainly to fibrous structures, in less part to the pelvic bone. The dissection of these intermingled masses of muscle and fibrous tissue was not easy, nor could the numerous particulars noted in the course of the dissection be given so as to convey a clear idea. But the following general account of the arrangement may be sufficient, noticing first the fibrous structures concealed within the fleshy masses.

Great Intermuscular Septa.—The longitudinal muscular masses all along the side of the pelvis, and backwards and forwards from it, are divided horizontally into an upper and a lower stratum by a thick sheet of white fibrous tissue, stretching out like a wing from each side of the pelvic cavity to beyond the pelvic bone and on a plane above the bone. This horizontal *fibrous plate*, as it may be termed, is of great extent and of great thickness. Behind the rectal fossa, it was traced for 6 inches (as far as the part removed for dissection allowed) and was there attached internally to the deep median fibrous septum. The median septum there shows, on transverse section, a diamond-shaped mass of fibrous tissue about 3 inches vertically, joined at the lateral angles by the fibrous plate. Forwards from this, along the side of the rectal fossa and for two inches outwards, the thickness of the fibrous plate was $1\frac{1}{4}$ inch; at four inches outwards, $\frac{3}{4}$ inch, diminishing outwards to about $\frac{1}{6}$ inch. Inwardly here it spreads over the whole rectal fossa giving it a fibrous covering $\frac{1}{2}$ inch in thickness, lined internally by the adherent fascia seen on the inner surface of the fossa (fig. 2). Along the anterior region of the pelvic cavity the thick inner edge of the right and left fibrous plates, continued from the raphé at the roof of the rectal fossa, form the boundary of the brim of the pelvic cavity, at first curving forwards and outwards, and then, when they have reached the part of the cavity in front of the bones, passing more directly forwards. The fibrous plate then passes forwards above the pre-pelvic band, concealed in the anterior muscular mass. At the side of the cavity the fibrous plate has above and below it the strata of the longi-

tudinal muscular mass, covered by the pelvic fascia passing down to be attached at the outlet to the pelvic bone and in front of that to the pre-pelvic band, smoothly lining and closing the cavity laterally and anteriorly.

Opposite the anterior region of the pelvis the fibrous plate passes outwards on a higher level than the pelvic bone and to beyond the bone. Here, external to the promontory, the fibrous plate shows itself as an edge, having bent down to interrupt the lateral longitudinal muscles. This part of the fibrous plate is seen in the dissection of the inferior aspect, as a free edge (fig. 2, *s*, *s*) passing semicircularly round and close to the promontory of the bone, from 6 inches behind the promontory forwards and inwards to about the middle of the beak of the bone. This part may be referred to as the semicircular septum. It has an attachment anteriorly to the beak of the bone, and sends two small bands inwards to the anterior border of the femur, seen in the figure. It had previously given off, under cover of the outer edge of the promontory, bands to the pelvic bone, directed inwards and forwards, attached on the upper surface of the bone two inches internal to the promontory. A continuation of this septum forwards is shown in the figure, seen on its edge on the right side, exposed on the left side (fig. 2, *f l*), separating a superficial longitudinal muscle from the neighbouring part of the longitudinal mass.

This great fibrous plate, concealed within the longitudinal muscular masses, thus furnishes an extensive surface for muscular attachment, far surpassing that of the pelvic bone, by which together the continuity of the entire muscular mass is interrupted; and, with its fellow of the opposite side, serves to form a more definite and fixed boundary to the pelvic cavity than the muscles alone would have formed. It may be said that, while the pelvic bone and post-pelvic band serve the purposes of the ischium, the great fibrous plate and the pre-pelvic band serve the purposes of the ilium and pubes of the quadrupedal pelvis.

(1) *The Posterior muscular mass.*—The anterior attachments, besides those to both surfaces of the fibrous plate, may be enumerated as follows. Those of the *under stratum* are shown in fig. 2 (*p*, *m*, *m*), the more superficial view on the left side

and in fig. 3 (*p, m, m*) the deeper attachments are seen. They are, from within outwards, to the post-pelvic band and neighbouring part of the wall of the rectal fossa; aponeurotic to the great interpelvic ligament; tendinous to the end of the pelvic bone; forwards and inwards to the inner part of the under surface of the pelvic bone; by a tendon, $1\frac{1}{2}$ inch long, $\frac{5}{8}$ inch broad, to the inner half of the posterior border of the femur; external to the promontory, broadly to the semicircular fibrous septum; fleshy to the great interpelvic ligament, and along the outer border of the bone to near the promontory; to the promontory by a narrow tendon; and to the semicircular septum, concealed by the part seen in the figure going to that septum. The first mentioned of these parts is seen to be soon attached behind to the median intermuscular septum. The attachments of the *upper stratum* are to the upper surface of the fibrous plate and to the fibrous roof of the rectal fossa, not to the pelvic bone. The bulk of the posterior muscular mass is partly shown in fig. 2 in the section made just behind the rectal fossa. The section is that of the under stratum only, and measures 12 inches by 4 inches.

(2) *The Anterior muscular mass.*—The attachments of the *under stratum* are shown in fig. 2 (*a, m, m*), differently dissected on the two sides. On the right side a distinct superficial muscle, 3 to 4 inches broad, is seen to arise behind from the semicircular septum, external to the promontory, and to be separated anteriorly from the rest of the longitudinal mass by the edge of the septum continued forwards from the semicircular septum. On the left side most of this muscle is removed, showing the surface of the septum with its transverse fibres; and to the inside of the latter is seen a portion of the superficial aponeurosis of the anterior muscular mass, left to show its relation to the tensor muscle of the interpelvic membrane. The attachments of the great part of the under stratum, besides that to the concealed fibrous plate, are, from within outwards, some bundles to the pre-pelvic band, passing shortly between it and the anterior median raphé; to the anterior half of the beak of the pelvic bone; to the semicircular septum, for 3 inches on the surface and deeply for more than that; and, external to this (as shown in fig. 3, *a, m, m*, right side), by a tendon, $1\frac{1}{2}$ inches

broad, to the bone in front of the promontory. This tendon is superficial and closely adherent to the semicircular septum. It is not shown in fig. 2, in order to show the course of the septum and the fibrous bands to the femur.

The *upper stratum* is attached to the fibrous plate, inwards to the brim of the pelvis and outwards to above the pelvic bone. This stratum is connected to the fibrous plate by a series of tendons which, if described backwards, might be said to form the fibrous plate by their expansion, giving the fibrous bundles of the anterior part of the plate a longitudinal direction. One of these tendons, at the anterior half of the pelvic wall, is nearly as thick as the wrist and 4 inches in length, streaked in the interior with muscular fibres, and gives origin to a great pyramidal muscle which soon blends with the rest of the mass. One tendon, mixed with muscular fibre, as large as a thick finger, goes outwards and backwards to join the fibrous plate in front of the promontory of the pelvic bone. Some tendinous bands are attached to the anterior half of the pelvic bone on its upper surface, but the greater part of the upper surface of the bone is not occupied. A few inches in front of the pelvic bone the two strata (except the superficial lateral muscle) blend, the fibrous plate having broken up and ceased. Fig. 2 shows the bulk of the anterior mass in section, at 6 inches in front of the pelvic bone, 12 inches broad by 4 inches deep, but I am not certain that this gives the whole depth of the mass. It had been noted at first as 9 inches by 6, and had probably become flattened on the table when the figure was drawn.

In regard to action, the posterior mass is among the moving powers of the long caudal region, the anterior mass belongs to the abdominal wall. Acting reversely, the posterior masses will retract the pelvis and narrow it; the anterior mass will advance the pelvis, its action in either narrowing or widening the pelvis will depend on the anterior attachments of its parts; the whole acting together will compress the abdomen and pelvis.

The *pre-pelvic band* (fig. 3, *pr. b.*) connecting the anterior ends of the pelvic bones, is a band of white fibrous tissue; at the middle on each side $\frac{1}{6}$ inch thick, much thicker at the middle line where it joins its fellow as the anterior symphysis of the pelvis; and is connected with the raphé between the anterior

muscular masses. It was probably this band that formed the fibrous tuft at the end of the pelvic bone in Mysticetus.

[*Comparison with the anterior and posterior muscular masses in Megaptera and in Mysticetus.*—The differences in *megaptera* are considerable. My notes of the dissection contain no reference to a horizontal fibrous sheet concealed within the masses. The only fleshy attachment of the masses to the bone, is that of the posterior mass to the hinder end of the bone, and for 3 inches along the outer side (fig. 15, 1888). For the rest, the fibrous interruption is on the surface in the form of a tendinous expansion, sent forwards external and superficial to the pelvic bone. Nor is there even any fibrous attachment to the pelvic bone anteriorly, except by two flat tendons near the promontory (*i i* of the figure), together not much larger than the corresponding tendon near the promontory in B. musculus (fig. 3, *a*, *m*, *m*). For 4 inches forwards, being the extent available for dissection, there was only fibrous tissue. Thus the flesh in megaptera, especially in front, does not come nearly so close to the pelvic bone as in B. musculus, nor, so far as I can judge, is its bulk so great as in B. musculus. The lesser bulk would account for the absence of the fibrous plate in megaptera. What is merely an intermuscular septum (the semicircular septum) in B. musculus is, in megaptera, elongated into an intervening tendon, a transformation often enough met with in anatomy. Comparing the pelvic bones in B. musculus and megaptera, the shortness of the beak in the latter may be accounted for by the much less attachment to it of the anterior muscular mass than in B. musculus.

In *mysticetus* (1881, figs. 13, 14, 17, 18), the posterior muscular mass showed no subdivision and was entirely attached, fleshy, to about the posterior half of the pelvic bone. The anterior mass was larger than the posterior, and the subdivisions of the fleshy mass are accounted for by the length and position of the femur. The whole of the attachments of both anterior and posterior masses were fleshy upon the bones. Besides the presence of a good-sized femur, the pelvic bone in mysticetus is very much larger than in the finners.

Exact comparison of the bulk of these muscular masses in these three species would be difficult, but on comparing the size of the sections now given in a full-grown mysticetus, in megaptera, and in B. musculus, and my full-sized drawings made during the dissection of each, it appears that the bulk of red flesh at and near the pelvis is much greater in B. musculus than in the other two. If so, that would accord with the great activity attributed to B. musculus, to which it owes its name. The great fibrous plate concealed within the masses in B. musculus appears to stand in relation to this greater muscularity.]

(C) *Muscles attached to the Femur.*

Besides the ligaments and other retaining fibrous bands above described, the femur has three direct muscular connections, a

posterior, an internal, and an anterior, and indirectly a fourth, connecting it to the anterior muscular mass. These are portions of muscles rather than muscles devoted to the femur, but they will act on it not the less. Being attached to a structure so rudimentary as this femur they deserve particular examination.

(1) *Posterior muscle of the Femur.*—This is one of the anterior attachments of the posterior muscular mass already noticed. Its different arrangement on the two sides is shown in the figures (fig. 2 and in fig. 3, *p m*). On the left side the tendon is $\frac{5}{8}$ inch broad at the middle by $1\frac{1}{2}$ inch long, and is inserted along rather more than the inner half of the posterior border of the femur; on the right side the tendon is a little smaller, attached to rather less than the inner half of the femur, and the fleshy portion is more isolated from the rest of the muscular mass than on the left side. At 4 inches from the femur, where the muscle becomes detached from the mass, it is 2 inches in breadth by $\frac{5}{8}$ inch in thickness. It is the strongest of the muscles attached to the femur, say, at the point mentioned, equal in bulk to the biceps muscle of the human arm, very large in proportion to the femur if regarded as for moving the femur. It may be regarded simply as one of the anterior attachments of the posterior muscular mass, for which the femur is rendered a fixed point by the resisting action of its anterior muscle.

(2) *Anterior muscle of the Femur.*—This muscle is a part of a large muscle (fig. 2, *t f*), the inner and greater portion (tensor fasciæ) inserted into the interpelvic membrane, the outer portion, about a $\frac{1}{4}$ of the whole, inserted into the femur. The entire muscle is as bulky as the palm of the hand, but of different shape on the two sides: on the right side fan-shaped, the apex forwards; on the left side square-shaped, owing to the outer portion being carried more forwards. The *tensor fasciæ* portion arises from the anterior part of the pelvic bone for $1\frac{1}{2}$ inch, beginning about 1 inch from the point. This narrow origin is by a short tendon from which fibrous septa, 4 or 5 in number, radiate backwards, giving origin to the fleshy fibres, forming a multi-penniform muscle. The outermost part of the tensor arises in part from the deep aponeurosis external to the bone and in part from a septum common to it and the femoral portion of the muscle. On the left side this septum received a

narrow slip of tendon direct from the posterior muscular mass, not present on the right side. The *femoral portion* of the muscle is bi-penniform, arises internally from the last mentioned septum, externally from the deep aponeurosis, and on the left side is prolonged forwards a little, giving the square shape and leaving a notch anteriorly between it and the tensor. Thus the entire origin of the femoral part is from movable fibrous structures, that of the tensor mostly from the bone.

The insertion of the femoral portion is along the inner half of the anterior border of the femur, by its median septum and flesh on each side, this being just opposite the insertion of the posterior muscle at the posterior border. But it is inserted also into the superficial aponeurosis for an inch before it reaches the femur, so that the femoral portion of the muscle is likewise a tensor of the fascia, not acting distinctively on the femur. The most posterior insertion of the greater portion (tensor fasciæ) is to the interpelvic membrane for about 4 inches transversely internal to the femur, its outer part reaching to the tip of the femur; and in front of this the insertion is on the deep surface of the interpelvic membrane along the posterior half of the length of the muscle. Length of the greater muscle, 4½ inches; breadth at the back, 4 inches: length of the femoral portion, 4 inches; breadth, 1½ inches. Thickness of the greater portion over ½ inch, of the femoral portion about ¼ inch. The femoral portion, besides being thinner, is mixed with fibrous tissue, giving it a ligamentous function in addition to its contractile function. The bulk of the femoral portion of the muscle is equal to three times that of the femur. The left was larger than the right; it weighed 4 oz. 50 grains, the right ½ oz. less.

The action of the entire muscle will be to move the femur forwards and inwards, but only along with the aponeurosis in front and internal to it. The femoral portion acting alone would move the inner end of the femur more directly forwards, but the close connection with the larger portion will cause a general inward and forward movement of the femur and of this part of the aponeurosis. Where the greater portion of the muscle is attached to the interpelvic membrane, the membrane is specially strong, almost like a strap crossing from side to side, the fibres curving backwards, as noted with the membrane and

as seen in fig. 1. The function of this pretty large muscle is not evident apart from that of resisting retraction of the femur by its posterior muscle, and of fixing the femur as one of the attachments of the posterior muscular mass. The external ligament of the femur is adapted to resist inward and forward traction as by this muscle acting as a whole. [No such muscle was found in connection with the femur or the interpelvic membrane in Megaptera.]

(3) *Internal muscle of the Femur.*—This muscle (fig. 3, *i m*, left side) is only in part attached to the femur, and consists of muscular fibre much mixed with fibrous tissue. It looks like a deeper portion of the tensor fasciæ muscle, but is separated from it by a tendinous covering. The origin of this sub-pelvic muscle is from the beak of the pelvic bone, beginning just behind the origin of the tensor fasciæ, and extending outwards for some inches as far as to between the femur and the pelvic bone. It divides into two parts, each about the size of the fore-finger; the anterior inserted into the semicircular septum and the bands from the septum to the femur, and in part to the tip of the femur; the posterior, passing between the pelvic bone and the femur, inserted into the outer and posterior part of the femur, on its deep surface; and a portion is continued, tendinous, to be attached to the pelvic bone, seen behind the femur and the posterior ligament of the femur, near the acetabular cartilage. The posterior portion of the muscle, that to the femur, is parallel to the portion of the posterior muscular mass that is continued forward on the under surface of the pelvic bone, but is distinct from it. The part to the femur looks at first more like a ligamentous structure, but striped muscular fibres are blended with the white fibrous tissue. This part of the muscle is smaller on the left side than on the right. The action of this sub-pelvic muscle upon the femur will be to move it inwards and a little forwards, like the tensor fasciæ muscle superficial to it, resisted by the external ligament of the femur. The part that is detached to pass behind the femur, to be attached again to the pelvic bone, can have no contractile action except slightly to assist in preventing the femur being lifted off the pelvic bone.

(4) *Connection of the Femur with the anterior muscular*

mass.—The anterior fibrous bands to the femur have been noticed as proceeding from the semicircular septum. They come from where that septum is intimately adherent to the deep surface of the tendon of the part of the anterior muscular mass shown in fig. 3 (*a*, *m*, *m*) and are common to both. These two bands (seen on the right side of fig. 2) are of considerable strength; length $\frac{3}{4}$ inch; breadth of one is $\frac{1}{2}$ inch, of the other $\frac{1}{4}$ inch; thickness about $\frac{1}{10}$ inch; direction backwards and a little inwards. That was on the right side; on the left side they were more broken up; on the right side attached more to the outer, on the left side more to the inner part of the anterior border of the femur. By means of these bands the anterior muscular mass here may move the femur a little forwards, or they may serve, with the anterior muscle of the femur, to resist retraction of the femur and to fix it as a point of attachment of the posterior muscle.

Summary of the Connections of the Femur and their Adaptations.

The various ligamentous and other fibrous retaining structures, and the muscular connections, now described, may be here summarised, reference again to the figures being implied.

Ligaments.—The external ligament, the strongest, is adapted to resist over-movement inwards and forwards; the posterior ligament to resist movement forwards and outwards; the interosseous ligament, small, mostly to resist forward movement.

Other fibrous retaining structures.—The superficial interpelvic and interfemoral membrane, attached all round the edges of the femur, retains it in its place generally, especially resisting inward and outward movement. The anterior bands resist backward and inward movement. The fibrous tissue mixed with the femoral part of the sub-pelvic muscle would resist outward and backward movement, but there is no muscle placed so as to produce that movement.

Muscles.—The femur is moved forwards and inwards by its anterior muscle together with the tensor fasciæ muscle, and deeply by its portion of the sub-pelvic muscle, together a strong muscular power; resisted specially by the external liga-

ment. It is moved backwards by its posterior muscle, a strong power, resisted only and not very exactly by the fibrous bands connected with the anterior muscular mass. The femur will be moved forwards by its anterior muscle, and a little through the bands connecting it to the anterior muscular mass; resisted by the posterior ligament, but it is not evident why the posterior ligament should be directed so obliquely outwards, unless the connection of the femur to the anterior muscular mass has a strong influence in moving it forwards and outwards.

All these attachments—ligaments, fibrous bands, and muscles, some of them very large in proportion to the femur—which I have endeavoured to trace with exactness, look like adaptations for the performance of various movements of the femur and for checking over-movement, but to no evident purpose. The comparison of the femur to a sesamoid bone, like the patella, is suggested, but there is no synovial membrane, no cartilage on the pelvic bone for the femur to play on, and no definite movement. Within the limits resulting from these attachments, and before any of them were divided with the knife, the femur slipped about loosely in the fingers in all directions. The attachments were not quite the same on the two sides, and, in the next B. musculus dissected, they may, not unlikely, be found to differ from those above described.

[In *megaptera* (fig. 15, *l*, 1888) the posterior ligament is the great one, and there is only one muscle attached to the much larger femur, contained within a division of that ligament. In *mysticetus*, the predominance of the posterior ligament (fig. 11, 1881) is still greater. The greater length and different position of the femur prevents any useful comparison of the muscles with those now described in B. musculus.]

III. Adaptations and Comparison of the Pelvic Bone and Femur in the different species.

(A) *Adaptations of the Pelvic Bone in relation to the soft parts in B. musculus.*

Although much reduced, compared with the innominate bone in mammals with a hind limb employed in locomotion, the pelvic bone in the cetacea is not a rudimentary structure. On the contrary it is fully and variously functional. The pelvic bones, in rela-

tion to the visceral chamber of the body, form a firm boundary on each side of the pelvic outlet, and they attach and form stretchers to the fibrous structures that complete the girdle before and behind; in relation to the reproductive organs, they attach and stretch the great transverse ligament on which the penis and its muscles are supported in the male; and they attach large muscles that, posteriorly, assist in moving the tail in locomotion, and, anteriorly, act on the abdominal and thoracic walls. The numerous muscular and fibrous parts attached to the bone and other relations to the soft parts in this B. musculus are fully given above, and may be referred to here only in relation to the form of the bone. That will be better understood by taking the full-grown bone.

The general concavity of the bone internally has reference to bounding the pelvic outlet. The thickness of the posterior portion of the bone is related, (*a*), to the attachment of a large amount of muscle along nearly its whole length; and, (*b*), to attaching, behind and for some way on the inner surface, the great interpelvic ligament for the support of the penis and for the attachment of various muscles. The lateral flattening of the anterior part of the beak appears to be related to attaching a considerable amount of muscle on one side, the external; and internally to inclosing the pelvic cavity. To the borders here are attached the pelvic fascia above, the interpelvic membrane below, the smooth flat periosteal surface forming a wall to this part of the pelvic cavity. The narrowing of the internal surface into a mere border, at the central part of the bone, corresponds to the flattening and expansion of the bone at this part. The upper surface is free, covered only by periosteum, except where it attaches a few fibrous bands; at two inches internal to the promontory, from the semicircular septum; and some on the beak, connected with the great intermuscular fibrous plate. The under surface, as seen in the figures, is mostly occupied by muscular attachments, though not of large muscles. The promontory, with the great breadth of the central part of the bone, is a striking character. This projection is not, like many long projections, for muscular leverage. A tendon of moderate size was attached near it in front, and a small tendon, which was not symmetrical, was attached to it from behind, but the

process proper is for the most part unoccupied by muscles, and lies free beneath the semicircular septum. The breadth and projection of this part of the bone would seem to stand in relation to the presence and retention of a femur, or to the presence of an acetabular cartilage. The external ligament of the femur is the most definite structure attached to the promontory, and it is interesting to notice that just external and posterior to this ligament is an area (as seen in figs. 2 and 3) to which neither muscle nor ligament is attached, and that this is the area of the acetabular cartilage, concealed beneath the periosteum.

(B) *Comparison of the Pelvic Bone in the Fin-whales and in Mysticetus.*

In Plate XX. figures are given of the pelvic bones in the Whale-bone whales I have had the opportunity of dissecting: a 14½-feet-long *Balænoptera rostrata;* a 36-feet-long *B. borealis;* and of the pelvic bone, and femur and its ligaments, of the 50-feet-long and of the 64-feet-long *B. musculus;* of a 40-feet-long *Megaptera;* and of a 35-feet-long and a 48-feet-long *Mysticetus.* They are all from males except that of the B. rostrata, and all the figures are reduced to $\frac{1}{6}$ the natural size. In making the comparison it is essential to bear in mind the degree of maturity of each, as inferred from the length of the whale.

(1.) Figure 6. This figure is from the young Lesser Fin-whale (*B. rostrata*, Pike-whale of John Hunter) stranded alive at Aberdeen, July 1870, the articulations of the cervical vertebræ of which I described in this *Journal*, 1872. Having reached only about half (14½ feet) the attainable length in this species, the bone figured cannot be regarded as typical. Total length, 3¼ inches, of which the anterior cartilage occupies $\frac{7}{8}$ inch, the posterior cartilage $\frac{6}{8}$ inch. The ossified part increases gradually in breadth backwards; breadth at the middle ½ inch, posteriorly $\frac{6}{8}$ inch; thickness $\frac{1}{8}$ to $\frac{3}{16}$ inch.

(2.) Fig 7 (R) and (L). These figures represent the right and left pelvic bone of the 36-feet-long Black whale (*B. borealis*, Rudolphi's rorqual) beached alive at St Margaret's Hope, Orkney, in the end of November 1884; as yet only referred to

occasionally in my account of Megaptera longimana, in this *Journal*, 1887–89. As the length of this species may reach 45 feet or even 50 feet, the figure cannot be regarded as representing the full-grown pelvic bone, but it may be taken as showing the general form in contrast with that of B. musculus. The bone of both sides is figured, as there is considerable a-symmetry. The chief differences are, that the bone of the right side has a well-marked promontory, that it presents a marked flattening and expansion towards the anterior end, and that it is somewhat broader generally, so that it is altogether more robust than the left, rendering it about a fourth heavier than the left. The total length was about 7 inches, of which the cartilages made $1\frac{1}{2}$ inches.[1]

On the bone possessing the considerable promontory, that of

[1] The dissection of the pelvic region was made in 1885, under pressure for time, only to the depth necessary to enable me to ascertain that a femur was not present. The parts were preserved for subsequent dissection of the muscles, &c., but, under the misapprehension that I was done with them, have been macerated since I left Aberdeen. In their natural position the pelvic bones were 12 inches apart, the hinder end 9 inches in front of the anus. The superficial compressor muscle of the penis and prepuce, and the superficial interpelvic membrane, had the same arrangement as described above in Megaptera and B. musculus. The former was 2 inches, the latter $\frac{1}{2}$ inch thick. The following particulars of the *ossified part* of the pelvic bones are given to show their a-symmetry. The measurements are in inches, those of the *right* side the *first* given of each measurement. Lengths, total $5\frac{4}{8}$ and $5\frac{6}{8}$; of the anterior portion $3\frac{6}{8}$ and $3\frac{7}{8}$; of the posterior portion, equal, $1\frac{7}{8}$. Breadth and thickness of the *posterior portion*, at the middle, breadth $\frac{7}{8}$ and $\frac{6}{8}$, thickness $\frac{7}{16}$ and $6\frac{6}{16}$; at the posterior end, breadth $\frac{11}{16}$ and $\frac{10}{16}$, thickness $\frac{7}{16}$ and $\frac{6}{16}$. The posterior portion is thus a little broader and thicker on the right than on the left bone. At the *promontory*, breadth $1\frac{1}{4}$ and 1; thickness, equal, $\frac{7}{16}$. Breadth and thickness of the *anterior portion*, at the middle, breadth $\frac{6}{8}$ and $\frac{5}{8}$, thickness, equal, $\frac{5}{8}$; at the broadest part anteriorly, being $1\frac{1}{4}$ inch from the end, breadth 1 and $\frac{5}{8}$, thickness $\frac{5}{8}$ and $\frac{6}{8}$; at the middle of the anterior flattened end, transversely $\frac{8}{16}$ and $\frac{9}{16}$, vertically $\frac{15}{16}$ and $\frac{12}{16}$. The change in proportion between these two last measurements is owing to the anterior end of the bone, especially of the right side, becoming flattened laterally, so that the thickness (vertically) exceeds the breadth (transversely). But the change in direction is not complete, the outer surface towards the anterior end facing obliquely outwards and downwards, so that the expanded anterior end of the right bone appears as if twisted on the part behind it. In the figures the bones are rotated a little so as to show the square-shaped expansion of the anterior end of the right bone. Thus, the right bone is broader than the left throughout, much so at the anterior end and at the promontory; the left bone is $\frac{1}{8}$ inch longer than the right, and, in thickness, loses as much on the posterior portion as it gains near the anterior end. The weight of the right pelvic bone is 571 grains, of the left 458.

the right side, there is on the promontory a marked oval area corresponding exactly to the area where the *acetabular cartilage* lies in the B. musculus and in the Right-whales. It is here ½ inch in length by ⅓ inch in breadth, and lies entirely on the under surface of the promontory, not extending round the edge of the bone. The surface is irregular, mostly excavated, and is quite like a surface which had sustained a cartilage. On the left bone, on which the promontory is but little developed, this mark is not present. The outer border of the promontory is thicker than that of the right bone, and along it there is a longitudinal depression, not reaching to the under surface of the bone. It does not look as if it had supported a cartilage, but rather to be the result of the growth of its margins. It may be that a well-developed promontory and the presence of an acetabular cartilage stand related. At fully ½ inch in front of the promontory there is a notch in the outer border of the bone, deepest and narrowest in the left, the least broad of the two bones. This notch corresponds in position exactly to the oval foramen noticed in the 64-feet-long B. musculus, as seen in fig. 9. One would expect such a foramen to be vascular, but in the B. musculus it was occupied by fat.

(3 *and* 4.) Figs. 8 and 9. The characters and differences of these two pelvic bones of the Razorback whale (*B. musculus*), one from a 50-feet-long, the other from a 64-feet-long, have been commented on above. In contrast with B. borealis they have great breadth at the central region with outward projection to form a promontory, and with this there is the presence of a femur. These two pelvic bones of B. musculus differ from each other very little in breadth at the central portion, but very much in the more mature specimen showing great prolongation of its anterior and posterior portions, much flattening laterally on the anterior half of the anterior portion, and great robustness on the posterior half of the posterior portion. As this species attains a length of from 60 to 70 feet, with an average of over 64 feet, this specimen may be regarded as nearly full-grown. Between the 50-feet-long one and the 64-feet-long one the increase in length, on the anterior portion of the bone from 9 inches to 13½, and on the posterior portion from 5½ inches to 10½, giving an increase on the total length of the bone from 10⅛ to 23

inches, is remarkable if the difference is merely a matter of age. There may be differences from variation, but we see at least the necessity for, if possible, having mature specimens for comparison. The shortness of the cartilages in the younger specimen (about the same length as in the more mature one), in striking contrast with their length, relatively to the ossified portion, in Megaptera, would seem to render doubtful that it could ever have attained such a length as that of the more mature specimen; but that raises the question of the mode in which ossification proceeds.

(5.) Fig. 10. This figure is from my account of the 40-feet-long Humpback whale (*Megaptera longimana*) in this *Journal*, 1888, the skeleton now placed in the museum at Dundee, in the neighbourhood of which this Megaptera first showed itself. As this species may attain a length of fully 50 feet, this specimen, judging by the attainable lengths of the two species, may be inferred to be about as far from maturity as that from the 50-feet-long B. musculus. In the latter the total length of the bone is $10\frac{1}{8}$ inches, in Megaptera $9\frac{1}{4}$, but the relative length of the anterior and posterior portions is very different; in B. musculus the anterior much longer than the posterior (respectively 9 and $5\frac{1}{2}$ inches), in Megaptera the anterior shorter than the posterior (respectively 5 and $6\frac{1}{2}$ inches). The shorter beak in Megaptera may be accounted for by there being no fleshy attachments to it, and tendinous attachments only near the promontory; but, looking to the relative size of the anterior and posterior muscular masses, it is not evident why in B. musculus the anterior part of the bone should be so much longer than the posterior, nor is it evident why the posterior part of the bone should be longer in a 40-feet-long Megaptera than in a 50-feet-long B. musculus.

A remarkable difference is in the lesser extent of ossification in Megaptera. The lengths in Megaptera are, ossified part $4\frac{1}{2}$ inches (straight) and about equally in the two portions; posterior cartilage $3\frac{1}{4}$ inches, anterior cartilage 2 inches. In B. musculus, ossified part $8\frac{1}{8}$ inches, posterior cartilage $\frac{3}{4}$ inch, anterior cartilage $1\frac{1}{4}$ inches. The progress ossification has made is perhaps not always a very reliable test of age. In this Megaptera a large part of the bone had still to ossify at the expense of the cartilages, in the B. musculus much further elongation could not

have taken place within the cartilages. In Megaptera the promontory is less projecting, and the breadth of the bone here is less; breadth in Megaptera 2¼ to 2½ inches; in the 50-feet-long B. musculus 4⅜ inches, in the more mature one 4 inches. In regard to this difference it may be noted that in Megaptera the femur lies more towards the inner edge of the bone, and is differently directed, so that its chief ligamentous attachment to the bone is not at the promontory, but behind.

(6 *and* 7.) Figs. 11 and 12. These figures are from among those given of the Greenland Right-whale (Balæna mysticetus) in this *Journal*, 1881. They are selected, the 35-feet-long one (probably about ⅔ grown) for comparison with the not mature B. musculus; the 48-feet-long one (probably full grown, being a male) for comparison with the mature B. musculus. Had the pelvic bone of the Megaptera been more fully ossified it might be taken, carelessly, for that of a Mysticetus younger than the 35-feet-long one, but the differences are marked. Especially the more transversely directed beak, and the shortness of the beak, relatively to the posterior part of the bone, would at once indicate Mysticetus. A comparison of the pelvic bone of a full-grown male and female Megaptera with those of B. musculus and Mysticetus is desirable should opportunity offer. These specimens enable that to be done between B. musculus and Mysticetus, and a glance at the figures will show that they are quite different both in the young and in the mature condition. In Mysticetus the shortness of the beak compared with the body, and still more the transverse direction of the beak, coming down in some of my specimens (as in figs. 1, 3, and 5, 1881) so as to form almost a right angle with the body; and the form of the body posteriorly, either very thick in the male or flat in the female, are characters by which the pelvic bone of that species may be at once known and easily distinguished from that of B. musculus. I have not had an opportunity of examining the pelvic bone in the female of B. musculus or of Megaptera, but in Mysticetus the great thickness of the hinder end of the bone in the male, and its flatness, usually with expansion, in the female, are characteristic. It is, indeed, easier to tell the male from the female pelvic bone in Mysticetus than to tell a male from a female pelvis in human anatomy. But that, within

these general characters, there may be great individual variation in the form and size of the pelvic bone is abundantly seen in my series of specimens of that bone in Mysticetus, some of which I figured in 1881. I may mention that some of these interesting specimens of the pelvic bone of Mysticetus, with the femur and with a model of the cartilaginous tibia attached, may be seen in the anatomical museums of Aberdeen, Glasgow, and Edinburgh Universities, in the Edinburgh Museum of Science and Art, and in the Natural History Museum, London, presented by me.

(C) *Comparison of the Femur in Fin-whales and in Mysticetus.*

In *mysticetus* (figs. 11 and 12, F) the femur is an ossified bone, of considerable length, varying from 4 to 9 inches, and, amid abundant variety in form, has certain definite characters, such as head, neck, tubercle for the great posterior ligament, and an enlarged distal end adapted for articulation with the cartilaginous tibia, forming the knee joint with a capsule and synovial cavity. In position, it lies nearly parallel to and partially behind the beak of the pelvic bone. At its outer end it forms the hip joint with the pelvic bone, resting on the acetabular cartilage on the back part of the promontory or in a more or less excavated acetabulum, a synovial cavity between, and is retained by anterior and posterior ligaments and by a tendinous capsule provided with three thin capsular muscles. To the body of the femur are attached a great posterior ligament and two small anterior ligaments, three small muscles from the pelvic bone, and anteriorly a great mass of muscle, from the anterior muscular mass, common to the femur and the beak of the pelvic bone. Yet, with all this apparatus for producing and checking definite movements, I found, in two of the eleven Right-whales in which the observation could be made, these functional adaptations rendered nugatory by complete bony ankylosis of the hip joint, in an adult male on both sides, in an adult female on one side only. The only function remaining was that of affording attachment to part of the anterior muscular mass in addition to that afforded by the beak of the pelvic bone.

In *megaptera* (fig. 10, F) the conical cartilaginous femur; in

length, $3\frac{3}{4}$ inches on one side, 5 inches on the other; lay antero-posteriorly across the beak of the pelvic bone, without hip joint or acetabular cartilage; connected behind by a strong ligament to the pelvic bone and the interpelvic ligament, and externally by a lesser ligament to the promontory; and was otherwise retained in position by anterior fibrous bands and by the general interpelvic and interfemoral membrane. It had one muscle only, concealed within one of the divisions of the posterior ligament, acting as a retractor. It could be under no other muscular influence except indirectly that of the posterior muscular mass, at a distance, through the fibrous membrane; and possibly that of the anterior muscular mass, at a distance, through the fibrous band sent forwards from the apex of the femur. Except as so far retained by these connections, the femur lay loosely and without any apparent function.

In *B. musculus* (figs. 8 and 9, F) the femur is reduced to the condition described above; in the 64-feet-long one, 2 inches in length and mostly ossified; in the 50-feet-long one, $1\frac{3}{8}$ inch in length, and entirely cartilaginous; retained by an external and a posterior ligament and by the general interpelvic membrane; with several portions of muscle attached to it, as described above; an acetabular cartilage present, but the femur not in contact with it and no synovial cavity present; except in so far as retained by these structures, lying loosely; the only function recognisable being that through the neighbouring muscles finding some attachment to it.

In the *B. borealis* and the *B. rostrata*, I found no trace of a femur. Reduced to a minimum in B. musculus, it has disappeared in B. borealis.

Concluding Remarks.—The result of the preceding inquiry is, I think it will be granted, the conclusion that the presence of this bone representing the thigh-bone in Fin-whales cannot be accounted for from the point of view of function, that it can be regarded only as a vestige. The significance of such vestiges in relation to the question of the origin of species is evident. A more rudimentary structure than this remnant of a femur in these great whales, it would not be easy to imagine. The femur in Mysticetus reduced and very variable, more reduced in Megaptera, reduced to a minimum in B. musculus, and

vanished in B. borealis. Some lessons in caution in the slippery exercise of seeking functional explanation of the presence of rudimentary structures occur in the above inquiry. After assigning functions to the muscles, ligaments, and synovial sacs of the hip joint in Mysticetus, we are met by the fact of the great variation of the bone, and by the fact of the occasional occurrence of stoppage of all movement by ankylosis of the hip joint without trace of disease; we see the acetabular cartilage not present in Megaptera which has the larger femur, but present in B. musculus which has the most reduced femur; we see the minimised femur of B. musculus with more and larger muscles attached to it than the larger femur of Megaptera has; and so on. It is necessary to the completeness of the inquiry to follow the anatomical details to the end, but in endeavouring to assign uses to rudimentary structures, we have to keep in view that such parts may in reality serve no purpose of functional utility, may be meaningless except as the products of decreasing heredity or as the incidents of variability, and that the parts attached to such structures may be but remnants or may be adaptations acquired amid the surrounding activities. The thigh-bone in this 50-feet-long whale would correspond, in a human body without its lower limbs, to a bone the size of a grain of wheat, concealed in the abdominal wall where the hip joint would have been, with a few threads of ligament and of the neighbouring muscles attached to it.

APPENDIX.

External Characters and Measurements of this Whale.

As I had a good opportunity of observing the external characters and of making careful measurements of this whale, assisted by Mr Robert Gibb and Mr George Sim, I give the following from my notes. These may be compared with those given in my account of the 64-feet-long B. musculus in this *Journal*, vol. vi., 1871.

Colour. Black on the back, white on the breast and belly. *Plaitings of the skin* (carcase lying on left side). Posterior limit, 26½ feet from point of lower jaw, 22½ feet from notch of tail. Highest plaitings run on level from angle of mouth to anterior edge of paddle; two run only ⅛ of that distance. Behind paddle they extend for about 10½ feet, the line of ending along the last half of that distance curved downwards with the convexity backwards. At anterior half of lower jaw the plaitings curve downwards and backwards before they be-

come horizontal. Here the ridges seem broader than further back, but this may be owing to the grooves being opened up. Thence on to the paddle they are narrow, about 1 inch in breadth, a few of the highest nearly 2 inches. Behind paddle and on the belly they are mostly 1¼ to 1½ inches broad, some scarcely 1 inch.

[This contrasts with the great breadth of the ridges in Megaptera, and their narrowness in B. rostrata. In my 40-feet-long *megaptera* the ridges were 4½ inches or more in breadth, the total number of ridges only 24. In my 14½-feet-long *B. rostrata* the ridges I noted across the breast were mostly ½ inch, some ⅝ inch; at their extreme ends before and behind, 1 inch, a few 1¼; the narrowest, below back part of mouth, ¼ to ½ inch; the total number of ridges just in front of the paddle was 57, between the eyes 66.]

Whalebone. Length of longest plates 20 inches; shortest, in front, 4 inches. Colour, on the outside, black or of deep slate colour; on the surfaces between the plates, slate colour; at the fringe of bristles, facing the mouth, and at the lower end of the plates outside as well as inside, of a dirty cream colour.

Paddle (pectoral fin). Length (including estimated 5 inches cut off at tip), on anterior border 6 feet; posterior border 4 feet 2 inches. Greatest breadth 16 inches. Position, distance from point of lower jaw to anterior border 15 feet 4 inches, to posterior border 17 feet 4 inches.

Tail Fin. Tip to tip 10 feet 3 inches; greatest breadth of lobe 2 feet 8 inches.

Dorsal Fin. Position, distance from middle of fin to edge of lobe of tail-fin, 13 feet 4 inches; from point of upper jaw, 37 feet; from point of lower jaw, 37 feet 8 inches. Form, falcate, anterior edge convex, posterior edge very concave, but point not much recurved. Height, requires definition; fin proper 14 inches, but rises 18 inches above general line of back from a 4-feet-long base. This base extends 20 inches behind and 28 inches in front of middle of fin proper, and has an elevation of 6 inches at its fore part and of 4 inches at its back part above the general line of the back. Thickness of fin proper, below, 2 inches.

Body. Total length of whale, from point of lower jaw to edge of lobe of tail-fin, measured straight, 50 feet; to notch of tail-fin, 49 feet 6 inches. Measured along the surface, to edge of lobe of tail-fin, 51 feet. Semi-circumferences of the region between neck of tail-fin and the dorsal fin:—at neck of tail-fin, surface much curved, 2 feet 2 inches; at ¼ of the distance forwards (2 feet 4 inches from neck), 3 feet 10 inches; at 3 feet from the neck, the most "razor-back" part, the form very compressed and sharp above and below, 4 feet 2 inches; at midway between the tail and dorsal fins (4 feet 8 inches from the neck), 4 feet 5 inches; at ¾ of the distance, 4 feet 10 inches. Position of preputial opening and of anus:—distance from point of lower jaw to centre of former, 32 feet 3 inches; to centre of anus, 36 feet 2 inches; from edge of lobe of tail to anus, 13 feet 4 inches.

Head. From point of lower jaw to outside of angle of mouth, 10 feet 3 inches; to inside of angle of mouth, 9 feet 9 inches; to middle of eye, 10 feet 2 inches. From point of upper jaw to front of blow-hole, 8 inches; length of blow-holes 13 inches. From eye to eye, centre of, round the top of the head, 7 feet. This line crosses at hinder end of blow-holes. Breadths of upper jaw, between point of jaw and back of blow-holes, taken on the surface:—at ¼ of that distance from point, 2 feet 3 inches; at mid-way, 3 feet 2 inches; at ¾ of the distance, 3 feet 10 inches. Breadths of lower jaw (edge of lip):—at middle (5 feet from point), 4 feet 11 inches; greatest breadth (nearly 8 feet from point) 6 feet 5 inches. From this point to inside of angle of mouth, along the curve, 3 feet.

Ear-hole. Position, 2 feet behind the eye and on the same level; size, just admits a rather small-sized goose quill, to the sigmoid stage.

Beard. Very few hairs remained. One I have preserved is fully ½ inch in length and is white.

EXPLANATION OF PLATES XVII.—XX.

All the figures are reduced to one-sixth.

Plate XVII. fig. 1. Superficial view of pelvic region. The dotted lines show the position of the femur, pelvic bone, and pre-pelvic band, covered by the superficial aponeurosis. The large muscle, *l*, *a*, the levator ani; *a* near the anus, surrounded by the internal sphincter ani muscle; on each side of the levator ani is seen the superficial edge of the post-pelvic band, attaching the levator ani and *a p*, the superficial aponeurosis. In front, *a p*, the superficial aponeurosis; *m*, between the pelvic bones, thickened part of the same, forming the interpelvic membrane or perineal fascia; stronger curved fibres of the membrane are seen internal to the femur where the tensor fasciæ muscle is attached. Through the window cut in the membrane are seen, in the centre, *r*, *r*, the retractor penis muscles, emerging from between the levator ani and the bulbo-cavernosus muscles; on each side a portion of the ischio-cavernosus muscle, *i*, *c*, on the crus penis.

Plate XVIII. fig. 2. Deeper view of same, superficial aponeurosis, levator ani and rectum removed, exposing the anterior and posterior muscular masses and muscles connected with the penis and the pelvic bone and femur, and showing the pelvic cavity and outlet. Posteriorly, *r*, *f*, the rectal fossa, or rectal portion of the pelvic cavity, with its fibrous wall and median raphé at the roof. Bounding the rectal fossa is seen the edge of the post-pelvic band, *po. p*, passing backwards from the pelvic bone to meet its fellow in the median intermuscular septum behind. On each side of the rectal fossa is seen the posterior or caudal muscular mass, *p*, *m*, *m*, the under stratum of it shown in transverse section on the right side. In front of the rectal fossa, *b*, *c*, the bulbo-cavernosus muscle with its median raphé, reaching only a short distance on the parts of the penis. In front of this muscle, in the middle, the bulb of the corpus spongiosum urethræ, with part of the crus penis on each side of it; on each side, the ischio-cavernosus muscle, *i*, *c*, concealing the outer part of the crus and of the corpus cavernosum penis. On each side of the penis and ischio-cavernosus muscle is the anterior region of the pelvic cavity *p*, *c*, shaded on the right side, blank on the left side, bounded externally by the pelvic bone, *P*, occupied at the outlet by fat. The very dark shading at the inner part of the anterior division of the pelvic cavity, and in front of the rectal fossa, shows, as far as possible in such a view, the inlet of the pelvic cavity. Bounding

the pelvic cavity in front, the pre-pelvic band, *pr*, *b* ; in front of this and the pelvic bone, the anterior muscular mass, *a*, *m*, *m*, shown in transverse section on the right side. Muscles and fibrous bands attached to the femur, *F*, here shown, are on the *left side* of the dissection, posteriorly, tendon from a portion of the posterior muscular mass, detached from the part of the mass passing forwards to be attached on the under surface of the pelvic bone; externally, the external ligament of the femur ; anteriorly, *a*, *m*, the anterior muscle of the femur, from the aponeurosis in front, and, continuous with that muscle internally, is seen the tensor fasciæ muscle, *t*, *f*, with its multi-penniform structure, passing from near the end of the pelvic bone backwards to end in the superficial interpelvic membrane, now dissected off. On the *right side* are seen, besides the posterior muscle and external ligament of the femur, the internal muscle of the femur, placed deeply on the pelvic bone and largely fibrous in its structure ; a portion of it is seen to pass out behind the femur to be re-attached to the pelvic bone behind the external ligament of the femur, and a larger portion is seen in front of the femur, attached to the anterior fibrous bands of the femur. External to the promontory of the pelvic bone is seen the edge of a fibrous inter-muscular septum, *s*, *s*, the semicircular septum. Seen attached to this septum are, posteriorly, a large portion of the posterior muscular mass; anteriorly, portions of the anterior muscular mass ; the septum is seen to give two fibrous bands to the femur, the anterior bands of the femur, and to extend inwards to be attached to the beak of the pelvic bone. It is seen also to be continuous anteriorly with a septum between a superficial lateral muscle, *l*, *m*, and the more internal part of the anterior muscular mass. On the *left side*, the deep fibrous layer, *f*, *l*, of which the latter septum is the edge, is shown by removing the greater part of the lateral longitudinal muscle. The triangular portion of aponeurosis, *a*, *p*, in front of the tensor fasciæ muscle, is a portion of the superficial aponeurosis left on to show the origin from it of the anterior muscle of the femur and the outer part of the tensor fasciæ muscle. The semicircular septum is part of the great fibrous plate that separates the anterior and posterior muscular masses into upper and under strata, here showing itself.

Plate XIX. fig. 3. Deeper view of the pelvic region. Pelvic bone, *P* ; *pr*. *b*, pre-pelvic band ; *i*, *l*, great interpelvic ligament ; *t*, *l*, triangular ligament; *b*, bulb of the corpus spongiosum urethræ, the oval mark shows where the urethra perforates the triangular ligament ; *c*, inner thick-walled part of the crus penis not covered by the ischio-cavernosus muscle ; *c'*, upper compressible part of the crus to which the muscle is attached; between *c* and *c'*, the fibrous ridge on the crus bounding the muscles ; *i*, *c*, ischio-cavernosus muscle. On the *right side*, *p*, *m*, *m*, parts of the posterior muscular mass, attached to the great inter-pelvic ligament and to the outer border of the pelvic bone ; in front of the latter attachment are seen, divided, the part of the posterior muscular mass inserted on the under surface of the pelvic bone, the part of the mass that forms the posterior muscle of the femur, and in front of these the internal muscle of the femur.

External to the femur, *f*, is seen its external ligament, and immediately behind this, the re-insertion of a portion of the internal muscle of the femur; *a*, *m*, *m*, tendon of part of the anterior muscular mass, attached to beak of pelvic bone, near promontory. Internal to this a larger portion of the anterior muscular mass. On the *left side*, *P*, the pelvic bone; *F*, the femur; *i*, *m*, the internal muscle of the femur, mixed with fibrous tissue; *p*, *m*, posterior muscle to the femur from the posterior muscular mass, attached to the internal elevation on the posterior border of the femur; partly concealed by the latter, the posterior ligament of the femur; external to the femur, its external ligament.

Figs. 4 and 5, the right and left pelvic bones, in their natural position and at the natural distance from each other, with the femur in its natural position, seen on their under aspect; *P*, the pelvic bone. The cartilages are indicated by the dotted areæ; *a*, *c*, the anterior cartilage, overlapping the bone for $\frac{1}{4}$ inch on the surfaces, more at the borders; *p*, *c*, the posterior cartilage; *p*, *y*, the promontory of the pelvic bone; *a c*, *c*, the dotted area, shows the position of the acetabular cartilage, the ovoid posterior portion the thicker part, the anterior portion reaching forwards on the under aspect of the promontory. The cartilaginous femur, *F*, shown in section on the right side, enclosed in its perichondrium; a short fibrous tuft is seen at the inner end of the femur. Fig, 5, *left side*, in addition, the ligaments of the femur, *e*, *l*, the external ligament, the strongest; *p*, *l*, the posterior ligament, attached to the external elevation on the posterior border of the femur. *Differences on the two sides* are shown; the left femur mostly in front of the pelvic bone, the right femur mostly upon (below) the pelvic bone; the promontory of the pelvic bone broader and less rounded on the right side than on the left.

Plate XX. figs. 6 to 12, series of views of the different form and size of the pelvic bone and femur (when present) in fin-whales and in the Greenland Right-whale, all reduced to $\frac{1}{6}$ the natural size. The cartilages are indicated by the dotted parts. Each is referred to more fully in part III., (*B*) and (*C*), of the text. All are from males except fig. 6.

Fig. 6. Pelvic bone of a young 14$\frac{1}{2}$-feet-long lesser Fin-whale, *Balænoptera rostrata*.

Fig. 7. Pelvic bones of a 36-feet-long Black-whale, *Balænoptera borealis*. Differences between the right and left are seen.

Fig. 8. Pelvic bone and femur, and ligaments of the femur, of the 50-feet-long Razorback whale, *Balænoptera musculus*, described in the text and seen in the previous figures. Cartilaginous femur, *F*; *e*, *l*, and *p*, *l*, external and posterior ligaments of the femur; *a c*, *c*, acetabular cartilage.

Fig. 9. Pelvic bone and femur of a 64-feet-long *Balænoptera musculus*. The femur is ossified in its outer, or here posterior, $\frac{3}{4}$; *e*, *p*, *l*, the external and posterior ligaments united before they reach the femur; *f*, *b*, fibrous band attached to anterior end of femur.

Fig. 10. Pelvic bone and femur, and ligaments of the femur, of a

40 feet-long Humpback whale, *Megaptera longimana*. *F*, femur; *f*, *b*, fibrous band continued from the anterior end of the femur; *p*, *l*, posterior ligament of the femur, the internal division, containing a muscle; *e*, *l*, external ligament of the femur in two parts. The great length of the posterior and anterior cartilages of the pelvic bone is seen. No acetabular cartilage present. The three lines crossing the femur indicate the outline of the pelvic bone, and the commencement of the anterior cartilage.

Fig. 11. Pelvic bone, ossified femur and its ligaments, and cartilaginous tibia, of a 35-feet-long (probably about $\frac{2}{3}$ grown) Greenland Right-whale, *Balæna mysticetus*. *P*, pelvic bone; *F*, femur; *T*, tibia; *a c*, *c*, anterior part of the acetabular cartilage; *a*, *l*, and *p*, *l*, anterior and posterior ligaments of the hip joint; *g*, *p*, *l*, great posterior ligament of the femur; *a*, *l*, *l*, two anterior ligaments of the body of the femur; *f*, *b*, fibrous bands attached to end of pelvic bone and to end of tibia; *c*, *l*, capsular ligament of the knee joint. The four lines crossing the femur indicate the outline of the pelvic bone, the commencement of the anterior cartilage, and the outline of the posterior part of the acetabular cartilage.

Fig. 12. Pelvic bone, *P*, ossified femur, *F*, and cartilaginous tibia, *T*, of 48-feet-long (adult) *Balæna mysticetus*. Cartilages and ligaments of the pelvic bone and femur not represented. Head of femur lodged in a deep acetabulum, overhung by a rough reverted ledge of the promontory. Process on posterior border of femur for attachment of great posterior ligament. Characteristic distal end of femur, anterior $\frac{1}{3}$ bevelled for muscular attachment, posterior $\frac{2}{3}$ adapted for articulation with tibia at knee joint, the whole end rough where it had been covered by the distal cartilage of the bone. The tibia (always cartilaginous) of characteristic form.

EDINBURGH, *March*, 1893.